GROLIER

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Grolier Incorporated
Danbury, Connecticut

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Dan In the Bible, Dan, the son of JACOB and Bilhah, the maid of RACHEL, is mentioned as one of the founders of the 12 tribes of Israel. Neither Dan nor the tribe of Dan, one of the smallest, receive much attention in the biblical narratives. The city of Dan, in northern Palestine, was a cultic center. Perhaps the most familiar Danite is SAMSON.

Dana, James Dwight The American geologist and educator James Dwight Dana, b. Utica, N.Y., Feb. 12, 1813, d. Apr. 14, 1895, is best known for his observation on the formation of the major features of the Earth's crust—the mountains, continents, and volcanoes. He was a professor of natural history and geology at Yale (1855–90) and wrote several standard texts, including five editions of a *System of Mineralogy* (1837). Dana developed the influential but now-abandoned theory that the Earth is cooling and contracting more under the crust than within it, and that the uneven contraction and gravity form GEOSYNCLINES and folded mountains, such as the Appalachians.

Dana, Richard Henry Richard Henry Dana, Jr., b. Cambridge, Mass., Aug. 1, 1815, d. Rome, Jan. 6, 1882, is best known for *Two Years Before the Mast* (1840), a classic sea memoir and defense of the rights of seamen, based on his own experiences as a common sailor on a voyage around Cape Horn. A Harvard-trained lawyer, Dana also wrote *The Seaman's Friend* (1841), a guide to maritime law, and *To Cuba and Back* (1859). Politically active, he was a founder of the Free-Soil party and a staunch opponent of the Fugitive Slave Laws.

Danaë see PERSEUS

Danaus [dan'-ay-uhs] In Greek mythology, Danaus was the king of Libya; his twin brother, Aegyptus, was the king of Egypt. Danaus had 50 daughters, the Danaids, and Aegyptus had 50 sons. After a quarrel between the brothers, Danaus pretended to give his blessing to a marriage of the cousins, but he gave each of his daughters a weapon with which to kill her husband on their wedding night. Forty-nine of the daughters did kill their husbands, and as punishment they were placed in Tartarus, in the underworld, and were forced to carry water in sieves forever. Only Hypermnestra spared her husband, and together they became the ancestors of the rulers of Argos.

Danbury Danbury is a city in southwestern Connecticut with a population of 65,585 (1990). Although known for the production of hats since before the Revolutionary War, Danbury now has a diversified industrial base. The city expanded significantly in the 1960s and '70s (the city limits were extended in 1965). Danbury was settled in 1685 and incorporated in 1702. The Danbury Fair, held annually from about 1820 and one of the largest fairs in New England, was disbanded in 1981.

Danby, Thomas Osborne, 1st Earl of Thomas Osborne, b. Feb. 20, 1632, d. July 26, 1712, best known as the earl of Danby, was, from 1673 to 1679, the leading minister under CHARLES II of England. Elected to Parliament in 1665, Danby was given (1668) the post of naval treasurer and promoted (1673) to lord treasurer. During the agitation to exclude the Roman Catholic duke of York (later JAMES II) from the succession, Danby rallied the group subsequently called the TORY PARTY in support of James. He later turned against James II and signed the invitation of 1688 asking William of Orange (WILLIAM III) to overthrow James. The new monarch rewarded Danby by making him lord president of the council (1690) and duke of Leeds (1694).

dance Dance is an expression in rhythmic movement of an intensified sense of life, arising from an inner per-

This 1832 painting of the Sioux Bear Dance by American artist George Catlin shows the intense force and movement of primitive tribal dance. Led by the chief medicine man, this dance was intended to summon the great Bear Spirit, who ensured food for the tribe.

ception that stimulates both mind and body. When dance as simple emotional expression develops into a design—a planned organization of a pattern of movement in rhythm, in space, and on the ground, with its set of steps, gestures, and dynamics—it becomes a specific dance. When this specific dance becomes a group of dances, stylized in a common design, it becomes a dance form. Dance forms, which may take centuries to develop, reflect the customs of the society in which they have evolved.

Depictions in prehistoric cave paintings in Europe suggest that some form of dance already existed during the Paleolithic Period. In the long, ensuing interrelation between dance and society, the dance has served many purposes: expressions of superstition, prayer, ritual, ceremony, social pleasure, entertainment, and art. Dance as participation, where the emphasis is on social expression in dance form, is termed *communal dance*; dance as spectacle, where the emphasis is on professional expression of a dance form, is termed *theater dance.*

Communal Dance

In primitive, early tribal cultures dance was a methodology for survival. Confronted by an environment that could be neither rationally controlled nor evaded, members of these tribes sought to transcend the consciousness of self by achieving an ecstatic state, in which they would arrive at a mastery over evil spirits.

Primitive Dance. The search for magical mastery over nature through loss of self is the distinctive characteristic of primitive dance. The ecstatic state was reached by the repetition of monotonous movements in powerful rhythm—the rhythmic beat to every movement, usually accompanied by drums; the hard stamping of the feet upon the ground, with bent knees; and the continuous, prolonged repetition of the basic movements. In the leap dance of Africa, in the whirling dances of primitive Asian tribes, or in the convulsive dancing of the shaman cultures, the purpose was the same: to reach a mystical condition in which the individual could communicate di-

In the Lion Dance, the Watusi people move quickly and rhythmically to obtain power over evil spirits. Watusi dances contain acrobatic movements which are symbols of tribal hierarchy.

(Above) *Dancing girls in this Theban tomb painting portray an Egyptian dance, a communal ritual reenactment of the death and rebirth of the god Osiris. (British Museum, London.)*

(Left) *This wall painting from an Apulian tomb (5th century BC) portrays a funeral dance. From earliest times, dance formed an integral part of Greek ritual.*

Pieter Bruegel's The Wedding Dance *(c. 1565) illustrates folk dancing in the center of the picture and social dancing in the left foreground. (Detroit Institute of the Arts.)*

rectly with the supernatural and in which the powers of the supernatural could work through that individual.

Ritual Dance. The distinction between primitive dance and ritual dance is that the latter is conscious dance, organized volitionally in its design, purpose, and meaning. Therefore, ritual dance represents a much later societal development, a level of civilization where dance celebrates mythology rather than magic. The rites of DIONYSUS in Greece, evolved in the early phase of its classic civilization (roughly 1500–1000 BC), were known for their ecstatic character, reminiscent of primitive dance in its abandon of self. Greek ritual dance during that period was characterized by the gentler forms of choral dance (round, chain, and processional dance), reflecting the Greek aesthetic emphasis on harmony and on idolization of the human body in natural rhythmic movement. The stylization of the choral dances led, in the later period of Hellenic culture, to the Greek chorus, a formalized dance element in Greek tragic theater.

Folk Dance. Reflecting the social and recreational expression of the peasantry in feudal society, FOLK DANCE developed from the racial or regional memories of older motifs in communal dance. Thus the chain dance, the processional, the whirling dance, and the circling dance all became characteristic of European folk dance. Ethnic dance, basically a preservation of dance heritage, developed distinctively characteristic styles, a specific and often difficult technique, and a concomitant terminology and schools of training. Moreover, ethnic dance was selective and more artistically conscious than folk dance; it offered a wide range of dance expression and was therefore more appropriate for theatricalization, ultimately evolving into theater dance. Folk dance, basically repetitious and limited in scope, achieved its own line of development in its transformations to social dance in Europe during the Renaissance.

Social Dance. Coupled dance emerged in 15th-century Europe in a variety of vigorous adaptations and refinements of folk dance developed by the dancing masters of the time. These new dances, gay and lively in character, developed first as a social diversion among the aristocracy of France and Italy, then expanded to become, in the later centuries, part of the social life of the emerging middle class as well.

The forms of social dance in Europe developed in three phases, each characterized by different designs in rhythm, space, and floor patterns. The nature of these dances reflected the related elements of the respective time periods—the elaborate and bulky fashions in clothes, the spacious floor areas of courts and palaces, and the elegance of the successive periods.

Each period can be characterized by its most popular dance: the age of the galliard (1500–1650), when that dance, bold and dashing in expanded movement, con-

This illustration of the minuet, from a 1735 dance manual, shows the circulating movement of an open couple across the floor. Within this structure, the couple performs a series of precise glides and steps. The minuet was a French dance introduced at the Court of Louis XIV in 1650.

(Right) *Break dancing is a form of modern street dancing thought to have started in the ghettos of New York City in the early 1970s. It combines spinning, gliding, floating, and "popping" movements.* (Left) *The waltz, the first ballroom dance to include close contact with a partner, expressed the vitality and passion of the Romantic Age.*

sisted entirely of leg thrusts and leaps and demanded the utmost vigor of the dancers; the age of the minuet (1650–1750), when the energetic, expanded, and leaping movements were transformed to close movement in formal, measured, small steps; the age of the waltz (1750–1900), when that dance, with its gliding turns, brought a new intimacy to social dance. There were, of course, other, even opposite, dance styles in each period. The courtly pavane and stately saraband were rivals of the galliard; the *contredanse* and quadrille competed effectively with the minuet; the polka and the mazurka challenged the supremacy of the waltz.

From the end of the 19th century, social dance belongs to the United States. The introduction of the two-step in 1891 was followed by the cakewalk of 1893, in turn followed by ragtime music. Vernon and Irene Castle, in the decade from 1910 to 1920, enchanted both Europe and America with their famous exhibitions of the tango (derived from Argentine folk dance), and the fox-trot. The African-American influence in jazz dominated in the 1920s with the shimmy and the Charleston, a form of the jitterbug. The 1930s incorporated Latin American rhythms, with the rumba, conga, and samba. In the mid-1950s the dramatic emergence of rock 'n' roll utterly changed popular music. Disco dancing of the 1970s re-

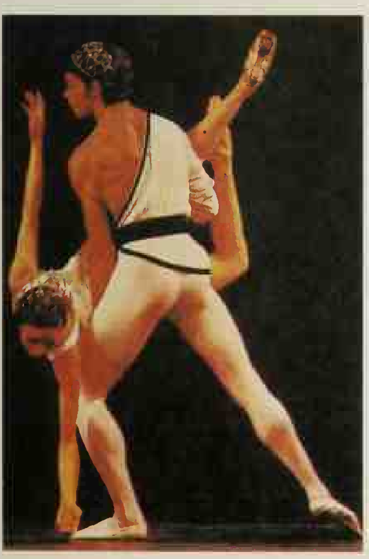
In this detail from Rehearsal on the Stage *(1871) by the French artist Edgar Degas, ballerinas reveal the beauty of the pointed foot in French romantic ballet. The choreography emphasized the grace and control of the prima ballerina. (The Louvre, Paris.)*

Victor Castelli, Karin von Aroldingen, and Tracy Bennett perform in the New York City Ballet production of Agon, *an abstract ballet choreographed by George Balanchine to the music of Igor Stravinsky. The emphasis on vigorous movement and "pure dance" is characteristic of Balanchine's work.*

This 1909 poster for the premier performance of the Ballets Russes in Paris was an invitation to the most influential ballet of the day. Serge Diaghilev, founder and director of the company, assembled the era's finest talents. (Dance Library, Paris.)

turned to couples together executing often complex, choreographed dance moves. Break dancing—street dancing that combined acrobatic and martial-arts movements—achieved popularity in the 1980s, and the lambada became a craze in 1990. (See ROCK MUSIC and RAP MUSIC.)

The role of composers of popular dance music in this development cannot be overestimated, nor can the many other elements that popularized American social dance throughout the world during the first half of the 20th century. Major influences were vaudeville, musical comedy, films, and such dancing stars as Fred ASTAIRE and Gene KELLY. Further reinforcement came from the accompanying technology, such as the mass impact of dance music on radio, records, and tape and dance images on television and, most recently, music videos.



Royal Ballet dancers perform a pas de deux *from Sir Frederick Ashton's 1946 work,* Symphonic Variations. *Abstract ballet and modern dance expanded choreographic possibilities. The theories of modern dance paralleled experiments of modern art and music.*

Theater Dance: Ballet

Ballet is a dance system based on a set of classic, fundamental principles of movement and training that govern every aspect of its form and technique (see BALLET and its accompanying glossary).

French Ballet. Ballet originated in Italy, in the princely courts of the 15th century. In 1581 the Ballet Comique de la Reine was produced at the court of King Henry II and Queen Catherine de Médicis of France. It was the first production to combine dancing, music, and acting around a central theme, and it stimulated the dedication of the French kings to ballet, intensified during the successive reigns of Louis XIII and Louis XIV, when the *ballet de cour* (court ballet) came into being and quickly dominated all European royal and ducal courts. Louis XIV became the most potent single influence on the development of ballet when he established the Académie Royale de Danse in 1661 and the Académie Royale de Musique in 1669, which survives today as the Paris Opéra. The trend toward professionalism then began—in training, technique, choreography, and music for ballet.

During the period from 1750 to 1800, the age of the great choreographer and theorist Jean Georges NOVERRE, the *ballet d'action*, which sought narrative coherence, was introduced. By 1830 ballet had entered a new phase—romantic ballet. It was also during this phase that a wealthy new middle class came into prominence in France, and ballet began to appeal to a larger audience. Romantic ballet reached its height in 1841 with the production of *Giselle* at the Paris Opéra—a ballet totally unified in theme, choreography, music, and narrative. The female dancers of the romantic period assumed the dominant role that the ballerina was to hold for ballet audiences for years to come.

Russian Ballet. The Imperial School of Ballet was founded in Saint Petersburg (now Leningrad) in 1738 but did not receive official patronage until 1766, when Catherine II established the directorate of imperial the-

Expressive uses of the eyes and face are important in the Bharta Natyam dance originating in southern India in the 5th century. Characteristics of Indian dance include elaborate symbolic uses of the arms and hands and sinuous posturing for this religious based drama.

aters, roughly a century after Louis XIV had established the Paris Opéra. In 1866 the directorate was extended to Moscow and the Petrovsky Theater, predecessor of the Bolshoi Theater. Russian ballet, during its ensuing development, became technically the finest ballet of the 19th century, especially under the direction of the choreographer Marius Petipa. It was the era of the great Russian ballerinas and the music of Peter Ilich Tchaikovsky, exemplified by such enduring ballets as *The Nutcracker, The Sleeping Beauty,* and *Swan Lake.*

The most brilliant impresario of Russian ballet was Serge Diaghilev, who formed the international Ballets Russes de Serge Diaghilev. Its debut in Paris, on May 19, 1909, changed the course of ballet history.

United States Ballet. Two ballet companies were formed in the 1930s that still creatively dominate ballet in the United States: New York City Ballet, founded in 1934, and American Ballet Theatre, founded in 1939. Ballet in the United States developed an impassioned audience in a comparatively short time, stimulating the formation of new ballet companies in many of the major cities of the nation. Important innovations in genre included contemporary narrative ballet, abstract ballet, and experimental ballet in various forms.

World Ballet. The United States, Great Britain, with its Royal Ballet, and the USSR, with the Bolshoi Ballet in Moscow and the Kirov Ballet in Leningrad, have the best-known companies and the largest audiences, but there are important ballet companies throughout the world that continue to re-create the classics and enrich the contemporary repertoire. There are, for example, the Royal Danish Ballet, the Royal Swedish Ballet, Germany's Stuttgart Ballet, the Dutch National Ballet (Het Nationale Ballet), and a number of French ballet companies, each with its own choreographic personality. Ballet is also performed by national companies in Prague, Budapest, Japan, Austria, Canada (three major companies), and Australia, to cite a few examples.

Eastern Dance Forms

The dance of India is essentially one of symbolic gesture. The bharata natyam, a dance system of movement and gesture derived from the *Natyasastra*, written by the an-

(Left) *A troupe of Romanian folk dancers in traditional costume performs a lively Balkan chain dance. Many such folk dances originated as specific festival celebrations, although they are performed on varied occasions today.* (Right) *Japanese dancers perform the 7th-century Bugaku court dance. Influenced by ancient Indian, Chinese, and Korean music and dance, the all-male Bugaku dancers move in deliberate steps to drums, bells and flute accompaniment.*

Flamenco is a Spanish dance with coordinated foot stomping and hand clapping to guitar, voice, and light percussion accompaniment. Originally a gypsy dance, Flamenco became a popular entertainment form.

cient sage Bharata, offers not only an entire repertoire of complex movements for the hands, limbs, and torso, but includes a set of 36 instructions for glances, to be used in expressing a range of emotions and thoughts.

Three other dance forms constitute the mainstream of theater dance in India. All originated in either religion or folklore, or in blends of both. These are kathakāli, a dance drama of Hindu mythology; kathak, a strongly rhythmic dance, with accelerated foot tapping and dynamic turns; and manipuri, a dance of vigorous movement and acrobatic agility, which plays a significant role in the contemporary renascence of theater dance in India.

Indian influence has been widespread in dance, blending with indigenous religious and folklore traditions. Some representative examples are the fire dances of Sri Lanka; the wayang-wong of Java, an extremely polished dance-drama-theater piece; and the legong of Bali, a pantomime dance in which the body is in simultaneous continuous movement, from eyebrows to feet. Chinese influence is also apparent in Southeast Asia, as in the dances of Cambodia and Thailand, which, although in the tradition of the mythological dances of the Indian kathakāli, are more action oriented.

In China, Beijing Opera is a fusion of drama and song, where every dancer is also actor, singer, and acrobat, and each has an independent set of hand gestures and movement patterns designed for the specific character role performed. In Japan preservation of the cultural past governs theater dance, as in the highly refined art form of NO DRAMA and the popular expression of KABUKI.

Western Ethnic Dance

There are a great number of notable ethnic dance companies in contemporary theater, notably the Moiseyev Dance Company (see MOISEYEV, IGOR ALEKSANDROVICH) of the USSR, the Inbal Dance Theatre of Israel, National Folk Ballet of Yugoslavia, Danzas Venezuela, Bayanihan Philippine Dance Company, and Ballet Folklórico de Mexico.

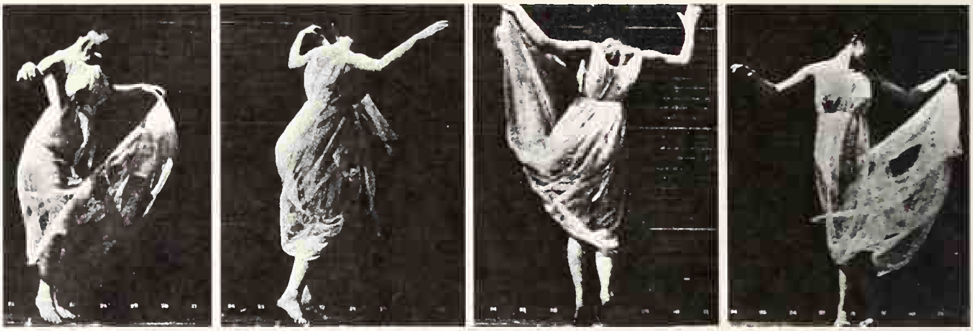
The oldest and most illustrative example in the West of a theater dance form that has retained its folkloric base is Spanish dance. Technically, it is the footwork in Spanish dance that is most characteristic—the striking of the toe, the heel, and the full sole in a variety of tonic and rhythmic combinations, accentuated by the click of castanets and the rhythms of an accompanying guitar.

The style was known in Greece in the 5th century BC; in the later dance spectacles of Imperial Rome the dancers from Andalusia were already on tour. The developmental influences of Spanish ethnic dance are a blend of Moorish, gypsy, and regional folk dance, exemplified in the FANDANGO, the FLAMENCO, and the BOLERO. The transition to an art form was accomplished almost single-handedly by La Argentina (Antonia Mercé) during the early years of the 20th century. In 1946, Ballet Español was formed, featuring José GRECO and Carmen Amaya.

Modern Dance

Introduced by the unique performances of Isadora DUNCAN at the turn of the century, MODERN DANCE is in fact neither a form nor a technical system. It is a point of view

Dancer-choreographer Mark Morris, dance director of Belgium's Royal Monnaie Theatre, performs in Dido and Aeneas.



American dancer Isadora Duncan was a leading innovator in expressive modern dance. Inspired by the fluidity and freedom of Greek art forms, Duncan based her costume design on classical draped statuary.

that stresses creative individuality in choreography and dance execution. In 1915, Ruth St. Denis and Ted Shawn founded the Denishawn School in Los Angeles, an event generally considered to be the beginning of the modern-dance movement. During the 1930s a number of European dancers, many of them disciples of Rudolf von Laban, the Hungarian-born dance theorist who developed unique concepts of movement and space relationships, began their own experiments. The most notable, in terms of their later influence, were Kurt Jooss and Mary Wigman. Another group of American dancers also emerged in the 1930s, not from dance schools but from the professional musical theater. Influential dancer-choreographers include Merce Cunningham, Alvin Ailey, La Meri, José Limón, and Twyla Tharp, among many other exponents of modern dance.

dance marathon The dance marathon, an endurance contest in which dancing couples were required to stay upright and in motion over long periods of time, was a phenomenon of the 1930s Depression. At first an inconsequential fad, by the mid-1930s the dance marathon reflected the desperation of the times. Contestants were fed and housed as long as they could continue dancing, and the marathon provided the sole means of subsistence for many. Usually, one 15-minute break each hour and a period of rest each night was allowed. The longest recorded marathon ran 4,152½ hours, from June 6 to Nov. 30, 1932. The prize was $1,000.

The dance marathon appeared during the Depression years of the 1930s. Couples competed for prize money in an endurance test of continuous dancing, with only brief rest interludes.

Dance of Death The Dance of Death, also called *Danse Macabre, Danse des Morts,* or *Totentanz,* emerged in medieval movement, theater, art, and literature as a spontaneous reaction to the hardships of the feudal system and the horrors of the Black Death, an epidemic of bubonic plague that from 1347 to 1350 killed a quarter of Europe's population. Sufferers of the plague (and of war, famine, and poverty) danced with desperate gaiety in graveyards—surrounded by skeletons, crosses, dead animals, and black draperies—as if enacting the superstition that the dead danced on their graves to lure the living. Although death was personified in paintings, poetry, and pageant as a dancer, the living dancers, originally only men, represented emperors, bishops, and peasants—all equal when facing death as nowhere else. In their macabre celebrations they confronted their mortality and championed death as the avenger over their masters and their hardships. Whatever physical form the allegorical dance assumed, it dealt consistently with death's universal inevitability, the equality of all people facing it, and the vanity of wealth and rank. Hans Holbein the Younger's series of woodcuts called *Totentanz* (1538) magnificently illustrates these themes.

Dance Theatre of Harlem Although its repertoire includes some ethnically based works, Dance Theatre of Harlem (DTH) is essentially a classical ballet company, founded by Arthur Mitchell and Karel Shook to provide African-American dancers with opportunities in that dance form. In 1968, Mitchell, until then a leading dancer with the New York City Ballet, opened a school in a Harlem garage and began to build a company that made its debut at the Guggenheim Museum in January 1971. Later that year DTH appeared at the Spoleto Festival in Italy.

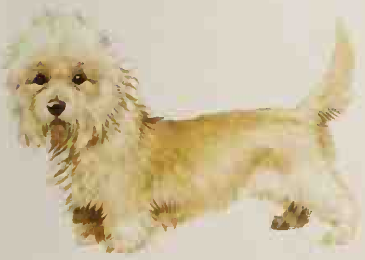
In 1974, DTH gave its first full New York season and appeared in London with great success. DTH's repertoire includes several ballets given by George Balanchine.

Mitchell has offered some encouragement to young choreographers, but the company remains best known for its performing skills.

dandelion The dandelion, *Taraxacum officinale*, is a widely distributed, yellow-flowered herb of the composite family, Compositae. A perennial of Old World origin, it is characterized by a thick primary root topped by a stem and a rosette of usually deep-lobed leaves. Each flower head is borne on its own scape, or stem, which may reach 45 cm (1.5 ft) high. Both male and female structures are present in the flower head, but seeds develop without pollination or fertilization. The seed, a small fruit (achene), has silky hairs that make it easily wind-borne. Although generally thought of as a weed, dandelions also are grown for their edible young leaves. The flowers, also edible, can be used in wine making.

The common dandelion, a ubiquitous weed, is the nemesis of those concerned with lawn care. Its greens are edible and provide a piquant addition to garden salads.

Dandie Dinmont terrier The Dandie Dinmont terrier is a long-bodied, short-legged dog with a domed skull, a topknot of silky hair, large eyes, and hanging ears. It is 20 to 28 cm (8 to 11 in) high at the shoulder and weighs from 8 to 11 kg (18 to 24 lb). Its coat is a crisp mixture of hard and soft hairs about 5 cm (2 in) long, and varies in color from pepper (bluish black to silvery gray) to mustard (reddish brown to pale fawn). The breed originated in the border country of England and Scotland, where it was used for hunting small animals. Its name is derived from a character in Sir Walter Scott's *Guy Mannering*.



The Dandie Dinmont, a terrier originating in the border country between England and Scotland, is named for the character who trained the breed for hunting in Sir Walter Scott's novel, Guy Mannering *(1815).*

dandruff Dandruff, also called seborrheic dermatitis, is a common condition in which the scalp becomes dry and itchy and the epidermis, or top layer of skin, starts to flake. It usually can be controlled by frequent washing with shampoo. Dandruff is often the sign of a skin disease such as a fungal infection. If severe, a dermatologist should be consulted.

Danelaw [dayn'-law] The Danelaw refers to those parts of northeastern England occupied by the Danes in the 9th century. It comprised the old kingdoms of NORTHUMBRIA and EAST ANGLIA and the districts of Derby, Leicester, Lincoln, Nottingham, and Stamford.

Settled by the Danes from 876 on, the Danelaw was largely restored to English rule in the reign of King EDWARD THE ELDER (d. 924), but Danish laws and customs persisted in the region for centuries. For example, at the time of the Norman Conquest (1066), a large number of free peasants, or "sokemen" (as distinct from serfs), lived in the area, probably the descendants of Danish settlers. The Danish influence is still present in place-names and dialects in certain areas of the Danelaw. The ridings (administrative areas) into which Yorkshire was divided until 1974 were survivals of a Danish institution.

Danger Cave Danger Cave, near Wendover, Utah, on the western edge of the Great Salt Lake region, is a major site of both the Paleo-Indian and Desert Archaic phases of North American prehistory. Its periods of intermittent occupation range from before 9000 BC until after AD 1400. (See NORTH AMERICAN ARCHAEOLOGY.)

Experts have recognized at least five occupation layers, up to 3.9 m (13 ft) deep in some sections. The dry environment of Danger Cave resulted in the exceptionally good preservation of the organic materials found at the site. Human skeletal, faunal, and floral remains of modern type and thousands of artifacts, including tools, clothing fragments, and ornaments, have been found. Significant changes can be traced in the material culture of the successive hunter-gatherer groups occupying the cave.

Daniel, Arnaut [dahn-yel', ahr-noh'] Arnaut Daniel, a Provençal troubadour poet active between 1180 and 1210, was the chief exponent of the style called *trobar ric*, which combines intricate verse forms and concise language. Imitated by Dante and Petrarch, his work was much admired by the American poet Ezra Pound and the French surrealist Louis Aragon.

Daniel, Book of Daniel, a book in the BIBLE, is listed with the Major Old Testament Prophets by Christians and with the Writings (Ketuvim) by the Jews. It comprises six stories of the trials of Daniel and his companions while they served at the court of Babylon, as well as four visions of the end of the world. The book takes its name, not from the author, who is actually unknown, but from its hero, a 6th-century Jew. Internal evidence indicates that the book was written during the Maccabean wars (167–164 BC).

Daniel is a form of APOCALYPTIC LITERATURE rather than prophecy; it is cast in symbolic imagery about the end of time and is attributed to an earlier authority. The book was intended to encourage Jews in the face of religious persecution by the Hellenistic kingdom of the Seleucids and their Jewish sympathizers.

Daniel, Samuel Samuel Daniel, *c.*1562–1619, was an English poet and dramatist best known for the sonnets in *Delia* (1592) and for his essay defending rhyme in English verse (1603). Attached to the court of James I, he wrote several masques and pastorals, as well as two Senecan tragedies—that on Cleopatra (1594) may have served as a source for Shakespeare. Daniel also wrote a verse epic (1595; rev. 1609) on the Wars of the Roses.

Daniels, Jonathan Worth As editor (1933–42, 1948–70) of the *Raleigh* (N.C.) *News and Observer*, Jonathan Worth Daniels, b. Raleigh, N.C., Apr. 26, 1902, d. Nov. 6, 1981, continued the traditions established by his father, Josephus Daniels. Books by Jonathan Daniels include a novel, *Clash of Angels* (1930); journalistic works, such as *A Southerner Discovers the South* (1938) and *Tar Heels: A Portrait of North Carolina* (1941); and a biography of Truman, *The Man from Independence* (1950). Administrative assistant to Franklin Roosevelt, Daniels recorded his experiences in *White House Witness, 1942–1945* (1975).

Daniels, Josephus Josephus Daniels, b. Washington, N.C., May 18, 1862, d. Jan. 15, 1948, editor and publisher of the *State Chronicle* (1885) and then of the *News and Observer* (1894) in Raleigh, N.C., championed prohibition, public education, women's rights, and railroad and utility regulation. His books include *Tar Heel Editor* (1939), *Editor in Politics* (1941), *The Wilson Era: Years of Peace* (1944), *The Wilson Era: Years of War and After* (1946), and *Shirt-Sleeve Democrat* (1947).

Danilova, Alexandra [dah-nee'-loh-vah] Alexandra Dionysievna Danilova, b. Peterhof, Russia, Nov. 20 (N.S.), 1904, enjoyed a long career as one of the world's leading ballerinas. In 1922–23 she was made soloist in the Soviet State Ballet. In company with George BALANCHINE and other dancers, Danilova toured Western Europe in 1924 and joined the BALLETS RUSSES DE SERGE DIAGHILEV in the same year. From 1933 to 1938 she was the senior ballerina of de Basil's BALLETS RUSSES DE MONTE CARLO, and from 1938 to 1952 was a star of the Blum-Massine (later, Denham) Ballet Russe de Monte Carlo. Danilova was spectacularly successful in Leonid MASSINE's *Boutique Fantasque* and *Beau Danube*, and she created the leading female roles in Balanchine's *Danses Concertantes* (1944) and *Night Shadow* (1946).

Danish art and architecture see SCANDINAVIAN ART AND ARCHITECTURE

Danish language see GERMANIC LANGUAGES

Danish literature Although poetry in the Danish language probably existed before the time of the Vikings, none was written down except some Latinized versions later rendered by SAXO GRAMMATICUS (fl. 12th century). Saxo's *Gesta Danorum* (Deeds of the Danes), which records the history of Denmark to 1186 and includes the earliest version of the Hamlet story, is the first ascertainable Danish contribution to world literature. A considerable corpus of medieval religious poetry in Latin also exists, as well as a great variety of folk ballads in the vernacular. Otherwise, the period from Saxo to the Reformation (1536) was marked by a pervasive German influence. Not until the 17th century would Danish poets, such as Anders Arrebo (1587–1637), author of a long religious poem, *Hexaëmeron* (1661), the lyrical Anders Bording (1619–77), and the hymn writer Thomas Hansen Kingo, choose their native language.

By the early 18th century, under the influence of the French Enlightenment and English rationalism, satires became the vogue. The result was the creation of a Danish drama, accomplished almost single-handedly by Norwegian-born Ludvig HOLBERG. His gay and witty comedies had an enormous impact on all later Scandinavian playwrights. Holberg may truly be called the father of modern Danish literature.

In the latter half of the century, Johannes EWALD, a writer of lyric poetry and heroic-verse tragedies, was the outstanding literary figure. Shortly after 1800, Adam OEHLENSCHLÄGER ushered in Danish romanticism, which he long dominated with his poems and historical dramas; Steen Steensen Blicher was the solitary representative of bleak realism. Among their younger contemporaries were Hans Christian ANDERSEN, the preeminent writer of fairy tales, and the Christian philosopher Søren KIERKEGAARD, whose influence would be fully felt only with 20th-century EXISTENTIALISM. About 1870 romanticism gave way to NATURALISM, the main exponent of which was the fiery critic Georg BRANDES. Among those he influenced were the novelist Jens Peter Jacobsen, the poet Holger Drachmann, and the joint Nobel Prize winners of 1917, Henrik PONTOPPIDAN and Karl GJELLERUP.

No single school dominated 20th-century Danish literature, although the proletarian novelist Martin Andersen-NEXØ and the lyric poet and novelist Johannes V. Jensen (Nobel Prize winner of 1944) were outstanding early in the century. The most famous of all modern Danish writers, Isak DINESEN, wrote her gothic tales and African memoirs in English. In the 1940s and 1950s, H. C. Branner excelled as a writer of short stories; poet Thorkild Bjørnvig and the novelist Klaus Rifbjerg won fame in the following decades. Such young neorealist novelists as Anders Bodelsen and Christian Kampmann and the science-fiction writer Sven Holm are outstanding contemporary writers.

D'Annunzio, Gabriele [dahn-noon'-tsyoh, gah-bree-ay'-lay] Gabriele D'Annunzio, b. Mar. 12, 1863, d. Mar. 1, 1938, achieved fame as a poet, novelist, playwright, lover, patriot, and adventurer. His exploits—literary, personal, and political—made him for 40 years a dominating presence on the Italian cultural scene and one of the most colorful and controversial figures in 20th-century Europe.

A precocious poet, D'Annunzio produced his first verse, *Primo vere* (1879), at age 16 while still under the influence of Giosuè CARDUCCI. He left Pescara for Rome in 1881 and almost immediately established himself as an important new lyric talent. The poems in *Canto novo* (New Song, 1882) demonstrated his extraordinary power to evoke rhythms, colors, sounds, and sensations in melancholy, idyllic settings. His short-story collections, such as *Terra vergine* (Virgin Land, 1882) and *Le Novelle della Pescara* (1884–86) set in his native Abruzzi, were in the realistic tradition of Giovanni VERGA.

Increasingly influenced by the French symbolists and decadents and, after 1892, by Nietzsche's glorification of the superman, he produced a series of *fin de siècle* novels notable for their amorality, sensuousness, and egocentricity. The best of these are *Il piacere* (1889; *The Child of Pleasure*, 1898), *L'Innocente* (1892; *The Intruder*, 1898; filmed as *L'Innocente* by Luchino Visconti, 1978), and *Il trionfo della morte* (1894; *The Triumph of Death*, 1896).

D'Annunzio's affair with the great Italian actress Eleonora DUSE, which began *c.*1894, led to his writing 18 plays. The most memorable of these were the neoromantic *La città morta* (1898; *The Dead City*, 1902); two tragedies written expressly for Duse, *La Gioconda* (1899; Eng. trans. 1902) and *Francesca da Rimini* (1902; Eng. trans. 1902); and *La figlia di Iorio* (1904; *The Daughter of Jorio*, 1907), probably his finest dramatic effort. The tempestuous relationship between D'Annunzio and Duse was echoed in his strongly erotic autobiographical novel *Il fuoco* (1900; *The Flame of Life*, 1900).

Gabriele D'Annunzio, an Italian writer and political figure, embodied the flamboyance of his life in his poetry, novels, and plays.

During the first decade of the 20th century, D'Annunzio produced his most powerful poetry, of which the patriotic *Laudi* cycle (1903–12) and especially the more personal *Alcione* (1904) rank high in modern European literature. With *La nave* (1908), his lifelong nationalism and pro-Latin cultural bias veered toward IRREDENTISM.

Danse Macabre see DANCE OF DEATH

Dante Alighieri [dahn'-tay ah-lee-gyay'-ree] Dante Alighieri, called Dante, b. Florence, Italy, June 5, 1265, d. Sept. 14, 1321, wrote the poetic masterpiece *La Divina Commedia*, or The DIVINE COMEDY, which helped establish his native Tuscan dialect as the literary language of Italy and made him not only Italy's preeminent poet but, along with Shakespeare, one of the towering figures of Western literature.

Of a middle-class Florentine family with some pretensions to ancient nobility, Dante received a good education both in the classics and in scholastic Christian literature. At a very early age he began to write poetry, largely love lyrics (*canzoni*) in the style of Guido Guinizelli and Guido Cavalcanti. According to Giovanni BOCCACCIO, Dante also studied painting and music. The most memorable events of his youth were his two encounters (1274 and 1283) with Beatrice Portinari, to whom he remained spiritually devoted for the rest of his life—in a metaphysical transformation of the tradition of COURTLY LOVE popularized by the Provençal troubadours—despite his own marriage (*c.*1285) to Gemma Donati (which produced several children) and Beatrice's to Simon de'Bardi. The progression of his love for her was embodied in the love poetry of his first book, *La vita nuova* (*The New Life*, *c.*1293), written a few years after Beatrice's death in 1290. In the much later *Divine Comedy*, she assumes the role of the poet's savior and guide and bears the allegorical significance of Faith or Theology.

In the political wars between GUELPHS AND GHIBELLINES (the pro-Papal and Imperial parties, respectively), Dante was originally a Guelph and in 1289 fought with his fellow citizens against the Ghibellines at the Battle of Campaldino. When the Guelphs later split into Black and White factions, Dante favored the Whites, who, suspicious of Pope BONIFACE VIII's designs on Florence, gradually took on the political coloration of the Ghibellines, whose ideal was a unified, peaceful Italy under the temporal authority of the Holy Roman emperor.

At the turn of the century, Dante held high public office, having risen from city councilman to prior and occasional ambassador of Florence. This career ended in 1301 when the Black Guelphs and their French allies

The Italian poet Dante Alighieri appears holding his masterpiece, The Divine Comedy *(c.1307–21), in Domenico di Michelino's* Dante and His Work *(1465).*

seized control of the city. In 1302 they confiscated Dante's possessions and sentenced the poet to permanent banishment from Florence and to the death penalty should he ever return. Thereafter Dante lived in various centers sympathetic to the Ghibelline cause, most notably at the courts of Can Grande della Scala in Verona and Guido da Polenta in Ravenna after the death (1313) of Holy Roman emperor HENRY VII finally ended his hopes for an imperial victory. This long exile marked the beginning of a steady literary output.

The unfinished *Convivio* (The Banquet, *c.*1304–07), in which he expatiates on his earlier love poetry, reflects his immersion in the pagan philosophers and cultivation of the Roman tradition. *De vulgari eloquentia* (*On the Vulgar Speech*, *c.*1304–06), in Latin, is a pioneering study of linguistics and style in which Dante argues for the use of the vernacular in serious works of literature and for combining a number of Italian dialects to create a new national language. *De Monarchia* (*On Monarchy*, *c.*1313), also in Latin, presents Dante's case for a world order united by one ruler who would be supreme in secular affairs, while the church, no longer a rival for worldly power, would remain sovereign in spiritual matters. Dante also experimented further with style and content in individual poems and wrote Latin epistles and eclogues.

Danton, Georges Jacques [dahn-tohn'] Georges Jacques Danton, b. Oct. 26, 1759, d. Apr. 5, 1794, was a dominant figure of the FRENCH REVOLUTION. Long extolled as the personification of patriotism, he has been neglected by recent historians because of his venality. He was, however, occasionally great, usually magnanimous, and always dauntless.

Born at Arcis-sur-Aube, Danton was well educated and became a prosperous lawyer in Paris. A big, broken-nosed man, mighty of voice, he gained notoriety by his defiance of the marquis de LAFAYETTE and the municipal council of Paris. Becoming an official of the latter body in 1791, he played an important part in replacing it on Aug. 10, 1792, by the revolutionary commune that overthrew the monarchy. Then, as minister of justice, he organized the defense of France against invasion.

Elected to the National Convention in September 1792, Danton was soon attacked by the GIRONDISTS for embezzlement and for condoning the September Massacres of prisoners by the Paris mob. He countered these charges by accusing his opponents of federalism. A regicide and an advocate of French expansion and emergency forms of government, he was nevertheless more realistic than doctrinaire in his goals. Controlling the Committee of Public Safety from April to July 1793, he sought to reconcile antagonisms and followed a moderate policy. Superseded by Maximilien ROBESPIERRE, Danton went to his home in Arcis, but returned to Paris late in the year to urge a relaxation of Terror. Branded as an "Indulgent" and sadly compromised by fraudulent friends, he was arrested soon after the execution of Jacques René HÉBERT. Following his dramatic appearance before the Revolutionary Tribunal, Danton, with 14 others, went to the guillotine.

Georges Jacques Danton, a leading figure in the French Revolution, became minister of justice after the overthrow of the monarchy in 1792. Brought to trial for antirevolutionary activities, he was found guilty and executed in April 1794.

Danube River The Danube (German, Donau) is the longest and the most important river in Central Europe and the continent's second longest river after the Volga. It rises in the BLACK FOREST of southwestern Germany and, after a course of 2,850 km (1,770 mi), flows into the Black Sea. With its tributaries, it drains an area of about 816,000 km^2 (315,000 mi^2). It flows through Germany, Austria, Hungary, Yugoslavia, and Romania; it borders Czechoslovakia, Bulgaria, and, in its delta tract, the USSR.

River's Course and Environment. The Danube's course can be divided into three parts. The river's upper course, from its source to Vienna, stretches generally eastward through the hills of southern Germany and Austria. It has several Alpine tributaries, including the Inn, Lech, and Isar.

On its middle course—from Vienna to the Iron Gate gorges on the border of Yugoslavia and Romania—the river flows alternately across lowlands and through mountain ridges. Most extensive of these lowlands is the Great Plain of Hungary, where the Danube is joined by the Tisza River from the Carpathian Mountains and the Sava and Drava rivers from the Alps. In the southeast of this plain, the Danube cuts across the encircling mountains in a series of spectacular gorges.

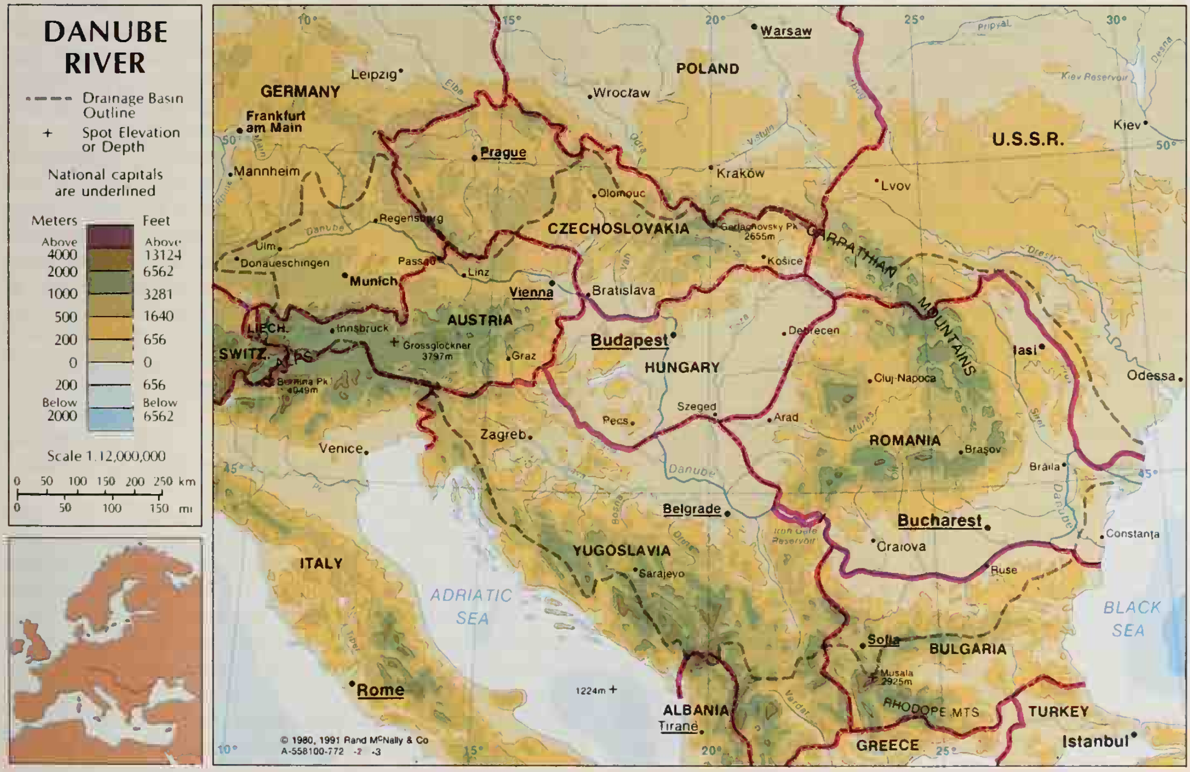
The third section, the lower course, lies across the plain of Romania and Bulgaria, but before it reaches the Black Sea it swings to the north, turns again to the east, and divides into the many channels of the delta.

Economic Development. The Danube is navigable from the sea up to Ulm, Germany, but many natural obstacles discourage navigation. The USSR and the countries of Eastern Europe almost totally dominate shipping from the mouth of the Danube to Budapest. Traffic is much lighter on the upper river.

The Danube suffers from a lack of linking waterways. Its only navigable tributaries are the Sava and Tisza. The Danube–Black Sea Canal in Romania, completed in 1984, bypasses the Danube delta and shortens the journey from central Europe to the Black Sea. The Djerdap, on the Iron Gate, is one of the largest hydroelectric complexes in Europe.

Danube school The Danube school was a group of early-16th-century south German landscape painters that included Albrecht Altdorfer, Matthias Grünewald, Lucas Cranach the Elder, Wolf Huber, and Jorg Breu. Their highly expressive views of nature are among the first true landscape paintings in the history of German art (see German art and architecture). Grünewald's *Isenheim Altar* (*c.*1513–15; Musée d'Unterlinden, Colmar) uses both the beauty and the ferocity of nature to augment the intense spiritual and mystical religious events depicted. Altdorfer's panoramic *Battle of Alexander* (1529; Alte Pinakothek, Munich) employs sophisticated atmospheric and aerial perspective as well as naturalistic details to create an image that ultimately evokes a sense of the primordial powers governing the universe. Altdorfer and Grünewald influenced the early styles of Jorg Breu, best known for his *Scenes from the Life of St. Bernard* (*c.*1500; Monastery of Zwettl, Austria), and Lucas Cranach the Elder. Altdorfer influenced his apprentice Wolf Huber, whose most notable painting is the *St. Anne Altar* (n.d.; Church of St. Nikolaus, Feldkirch).

Danzig see Gdańsk



Daode Jing (Tao Te Ching) [dow-duh jing] A philosophical classic by LAOZI, the *Daode Jing* is the single most important text of Chinese DAOISM. According to tradition, the sage composed its approximately 5,000 words in the 6th century BC at the request of a gatekeeper who wanted a record of his teachings. The book is now considered to date from the 4th century BC. Laced with richly poetic imagery, it counsels balance, restraint, simplicity, and the avoidance of activity and desire as the means of achieving harmony with the natural currents of the *dao*, or universal way. In ancient China, Laozi's thoughts rivaled those of Confucius in popularity; hundreds of commentaries and translations exist.

Daoism (Taoism) [dow'-izm] The term *Daoism* refers to a movement that developed alongside CONFUCIANISM into both a philosophy and a religion, becoming one of the major belief systems in traditional China. The DAODE JING, sometimes called the *Laozi* for its legendary author, and the *Zhuangzi* stand as the core texts of Daoism.

Daoist Philosophy. The Daoist movement began during the Eastern Zhou dynasty (*c.*770–256 BC) when religious hermits challenged Confucius's socially responsible *dao* (prescriptive doctrine, or way). Early Daoist iconoclasts advocated ASCETICISM, HEDONISM, and EGOISM as the way. Mature Daoist theory, however, began with the slogan "abandon knowledge, discard self," as advocated by Shen Dao (*c.*4th century BC). He argued that there is only one actual *dao* and that to follow several prescriptive ways is a distraction from this natural, inevitable course of action.

The philosophy of the LAOZI (*c.*4th century BC) developed Shen Dao's slogan into a psycholinguistic theory in which doctrines were said to create "contrived" action (*wei*) by shaping desires (*yu*). The process of learning the names (*ming*) used in the doctrines trained individuals to make distinctions between, for example, good and bad, beautiful and ugly, high and low, and "exists" (*yu*) and "exists-not" (*wu*), and thereby shaped desires. To abandon prescriptive knowledge, then, was to abandon names, distinctions, and socially induced tastes or desires. Thus spontaneous behavior, or non-contrived action (*wuwei*), resulted.

Shen Dao's original prescription to give up all prescription and Laozi's primitivism (his seeming advocacy of giving up name-motivated, conventionally conditioned action) are both virtually incoherent. To follow such advice is to ignore it. The analytic school, which advocated names in China, made this succinct criticism of early Daoism: to say "all language is perverse" is perverse. In other words, if what is said is acceptable then it is perverse.

ZHUANGZI (*c.*399–*c.*295 BC), intimately familiar with the analytic arguments, constructed a more coherent version of Daoist theory. Rather than treating all language as perverse, he allowed that all language use was equally natural—all the disputing theorists were equally "pipes of heaven." Because all language expresses a contextual standpoint, or perspective, from which terms such as *this* or *that* (which have no fixed relation to the world) are used, any attempt to judge or rank perspectives itself must be from some perspective. Thus, all ways of dividing the world into "things" remain equal. None has privileged status. None is uniquely the doctrine of heaven and nature.

Daoists offer incense and food to their deified ancestors. True Daoist philosophy does not countenance ancestor worship, but the practice has been incorporated into religious rituals from Chinese folk tradition.

It is not necessary, however, to give up language or to stop following doctrines. Humans naturally advocate and follow doctrines just as fledgling birds naturally tweet and twitter. Zhuangzi advocated openness to all perspectives, suggesting myriad ways to evaluate one's way through life. Flute playing, butchering, and the analysis of names are among the traditional examples given for training responses. Daoist mastery can be achieved through any skill and can be characterized by the mystical sense of having transcended deliberate skill through guidance of the *dao*. Undiscovered ways may teach techniques of unimaginable power. Although Zhuangzi argued against the preference for life over death, Daoist religion came to strive for a way, among the infinite number of undiscovered ways, that led to long life.

Daoist Religion. Religious Daoism was associated with legalism and the cult of the YELLOW EMPEROR, and it became popular after the suppression and decline of classical thought during the 3d century BC. Daoist experimenters in breathing practices and ALCHEMY caught the fancy of superstitious monarchs seeking immortality. These rulers promoted the compilation of such books as the *Lie Xi* (comp. during Han dynasty, 202 BC–AD 220) and the *Huai Nan Xi* (*c.*100 BC), which cited fragments of the classical Daoist tests in support of every known occult practice.

Daoist sects based on the supposed *dao* of any one of thousands of local folk deities or archaic culture heroes (including Laozi and the Yellow Emperor) spread throughout China. Experimentation continued in meditation, sexual practices, hygiene (internal alchemy), and travel in search of the secrets of long life. Still tinged with classical anarchist impulses, major sects—such as the Celestial Masters movement, headed by Zhang Daolin (*c.*2d century AD), and the Yellow Turban movement—often battled the imperial government.

Daoist religion provided a foothold for the introduction of Buddhism and influenced the form of its elaboration in China. Daoists developed a collection of over 1,400 scriptures known as *Daozang*. Religious Daoism and BUDDHISM have blended in the minds of most ordinary Chinese believers, found now principally in Hong Kong and Taiwan.

Daphne In Greek mythology, Daphne was a mountain nymph loved by APOLLO. Apollo pursued Daphne, but her father, a river god, turned her into a laurel tree. Apollo promised that the tree would be eternally green and took the laurel as his symbol.

daphne Daphnes are about 50 species of small, deciduous or evergreen shrubs constituting the genus *Daphne* in the mezereon family, Thymelaeaceae. Native to Europe, North Africa, and Asia, they are grown worldwide for their attractive foliage and fragrant flowers. Some species are also called garland flower, spurge laurel, and mezereon. The last, *D. mezereum*, a deciduous European shrub now naturalized in parts of the northern United States, has lilac-purple flowers. Its bark, leaves, and red, berrylike fruit are poisonous.

Daphnia see WATER FLEA

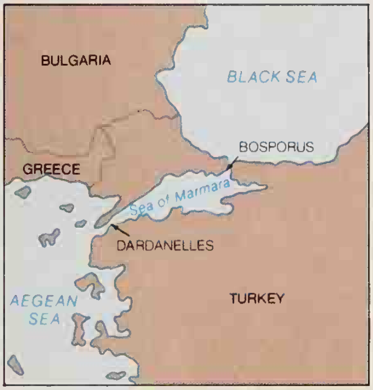
Daphnis In Greek legend, Daphnis was a Sicilian shepherd, son of the god Hermes. He was credited with originating pastoral (bucolic) poetry. Daphnis is also the name of one of the two main characters in *Daphnis and Chloe*, a Greek pastoral romance written by Longus around the 3d century AD, which formed the basis for a ballet (1912) by Mikhail Fokine and Maurice Ravel.

DAR see DAUGHTERS OF THE AMERICAN REVOLUTION, NATIONAL SOCIETY OF THE

Dar es Salaam [dar es sah-lahm'] Dar es Salaam (Arabic for "haven of peace") is the capital, chief port, and largest city of Tanzania, with a population of 1,394,000 (1985 est.). It is situated on the Indian Ocean, about 60 km (45 mi) south of Zanzibar. Most of Tanzania's manufacturing is concentrated in Dar es Salaam. The city is the terminus of railroads and pipelines. Its port handles about 25% of southern Africa's overseas trade.

Founded (1862) by the sultan of Zanzibar on the site of the village of Mzizima, Dar es Salaam was a minor port until the German East Africa Company took control in 1887. It has served as capital of the country since 1891. The construction (1907) of the railroad significantly increased the city's economic importance.

Dardanelles The Dardanelles is the 61-km-long (38-mi) strait between the Aegean Sea and the Sea of Marmara. It is the westernmost section of the waterway that divides Europe from Asia and connects the Mediterranean and Black seas. The narrow (1–6-km/¾–4-mi) strait lies within present-day Turkey, where it is called the Strait of Çanakkale. Called the Hellespont in ancient times, the strait is associated with the legend of HERO AND LEANDER. The modern name comes from Dardanus, mythical ancestor of nearby TROY. Despite unpredictable weather and swift surface currents, the Dardanelles has been a strategic water route—and an object of conquest—throughout history. Long controlled (1402–1918) by the Ottoman Empire, it was a primary factor in the EASTERN QUESTION of the 19th century and the scene of an intensive Allied campaign in World War I.



The Dardanelles, the strait separating European and Asian Turkey, is strategically important for control of shipping from the Black Sea to the Mediterranean.

Dare, Virginia Virginia Dare, b. Aug. 18, 1587, was the first English child born in what is now the United States. Her parents were members of the colony founded under the sponsorship of Sir Walter RALEIGH on Roanoke Island in present-day North Carolina. The child disappeared with all the other colonists sometime before 1591.

Darío, Rubén [dah-ree'-oh, roo-bayn'] Rubén Darío, pseudonym of Félix Rubén García Sarmiento, b. Jan. 18, 1867, d. Feb. 6, 1916, was a Nicaraguan poet who led the modernist movement in Spanish America. The principal poet writing in Spanish between 1890 and 1916, he so effectively increased the possibilities of poetic expression that he is still a force in Hispanic poetry.

By age 12, he was the established poet of Nicaragua, by 16, of all Central America; with the appearance, in Chile, of *Azul* (Blue, 1888), he won worldwide Hispanic recognition. In Argentina he wrote for *La Nación* and in

1896 published *Los raros* (The Rare Ones) and *Prosas profanas* (Profane Hymns), which won many to an appreciation of modernism. His later books of poetry include *Cantos de vida y esperanza* (Songs of Life and Hope, 1905), *El canto errante* (The Rambling Song, 1907), *Poema del ontoño* (Autumn Poem, 1910), and *Canto a la Argentina* (Song to Argentina, 1914).

Darius I, King of Persia (Darius the Great) [duh-ry'-uhs] Darius I, an ACHAEMENID king who ruled from 522 to 486 BC, is considered the restorer of the Persian Empire. Born *c.*550, the son of Hystaspes, he became king after killing the priestly usurper Gaumata, who claimed to be Bardiya, younger brother of Cambyses II. Darius fought many rebels against his authority in the first years of his reign and left a record of his struggles in a relief and a trilingual inscription of major linguistic importance on a rock at BEHISTUN.

Darius reorganized the Achaemenid empire into provinces called satrapies. Many other reforms are attributed to him. He organized the famous postal system on the royal roads, the striking of gold coins called *darics*, and the Achaemenid bureaucracy. He is said to have ordered the creation of a cuneiform script for the Old Persian language, and he started the complex of palaces and buildings at PERSEPOLIS.

Darius invaded the Balkans and southern Russia but was forced to retreat from the latter. Continuing the PERSIAN WARS with the Greeks, he sent an army against Athens, but it was defeated in the Battle of Marathon in 490 BC. He named his son XERXES I as his successor.

See also: PERSIA, ANCIENT.

Darius I (seated), *Achaemenid king of Persia, appears with his successor, Xerxes, in this bas-relief (5th century* BC*) from Persepolis. To punish the Greek states for their support of the Ionian revolt against Persian rule, Darius ordered the invasion of Greece. His army was defeated at Marathon (490* BC*) in one of the most famous battles of ancient times.*

Darjeeling Darjeeling is a city in West Bengal state, India. Its population of 56,857 (1981) is primarily of Nepalese descent. It lies at an altitude of 2,100 m (7,000 ft) in the foothills of the eastern Himalayas, close to Nepal and the state of Sikkim. Darjeeling is a commercial center for the tea (for which it is famous), grains, fruits, and vegetables grown nearby. It has long been a popular hill resort because of its beautiful scenery and moderate temperatures. The snow-clad peaks of Mount Everest and Kanchenjunga can be seen from the city. During the 1830s the British bought the city from Sikkim and used it as the summer capital of Bengal.

Dark Ages Dark Ages is the name traditionally given to the period in European history from the fall of the Roman Empire in the west (5th century) to the coronation of Charlemagne (800), or sometimes to the 10th century. The term has also been used to denote the entire MIDDLE AGES down to the Renaissance (15th century). Modern historians avoid using the term because of its implications of barbarism and intellectual darkness.

dark horse A dark horse, in U.S. politics, is a relatively unknown person who is nominated for an important office by a major party. Dark-horse candidates have been selected to run for the U.S. presidency on occasions when party conventions have become deadlocked between two or more strong rivals. In 1840, William Henry Harrison was the Whig party's dark-horse candidate, agreed on as a compromise between Henry Clay and Daniel Webster. In 1920, Warren G. Harding won the Republican nomination when the convention became deadlocked following successive balloting for two other leading contenders.

Darlan, Jean François [dar-lahn'] French admiral Jean François Darlan, b. Aug. 7, 1881, d. Dec. 24, 1942, joined Marshal PÉTAIN's proarmistice government as minister of marine on June 16, 1940. The rival of Pierre LAVAL for influence with the aged Pétain in the VICHY GOVERNMENT, Darlan became Pétain's intended successor in February 1941. In Algiers during the American landings in North Africa in November 1942, Darlan reached an agreement with Gen. Mark Clark to end French resistance. The following month he was assassinated by a young Frenchman.

Darling River The Darling River, a 2,700-km-long (1,700-mi) river in southeastern Australia, rises in the GREAT DIVIDING RANGE near the border of Queensland and New South Wales and flows southwest, joining the MURRAY RIVER at Wentworth. Although the river has many tributaries, including the Culgoa, Warrego, Gwydir, Namoi, Macquarie, and Bogan rivers, its flow is intermittent. Dams and reservoirs on its lower course supply water for many irrigation projects. The explorer Charles STURT discovered and named the Darling River in 1829.

Darmstadt [darm'-shtaht] Darmstadt (1986 est. pop., 133,600) is a city in the state of Hesse, Germany, lying south of Frankfurt. It is an industrial center that manufactures chemicals, machinery, and steel. In existence from at least the 11th century, Darmstadt was deeded to the landgraves of Hesse in 1479. From 1567 to 1918 it was the residence of the ruling family of Hesse-Darmstadt, which became a grand duchy in 1806. Darmstadt had its richest period in the early 19th century under Grand Duke Louis I (Duke Louis X). The city was badly damaged in World War II, but many historic landmarks remain.

Darnley, Henry Stewart, Lord Henry Stewart, Lord Darnley, b. Dec. 7, 1545, d. Feb. 9–10, 1567, was the second husband of MARY, QUEEN OF SCOTS. The son of Matthew, 4th earl of Lennox, he began to court the young Mary in February 1565. They were married according to Roman Catholic rites on July 29, 1565, much to the displeasure of the earl of Moray (who was Mary's half brother), the powerful Hamilton family, and John KNOX. What appeared for dynastic reasons to be a good match soon soured. Darnley's jealousy of David Riccio, Mary's secretary, led him to take part in Riccio's murder (March 1566), and this alienated him from the queen, who had grown tired of her weak and inconsiderate husband. There is no proof of her complicity in Darnley's murder at Kirk o' Field, but she subsequently married the earl of BOTHWELL, who probably authored the plot.

Darrow, Clarence S. Clarence Seward Darrow, b. Kinsman, Ohio, Apr. 18, 1857, d. Mar. 13, 1938, became famous as a criminal-defense lawyer. After a career as a successful corporation lawyer, he turned to labor law under the influence of Illinois governor John Peter ALTGELD. In 1895, Darrow conducted an unsuccessful defense of the labor organizer Eugene V. DEBS, who had been charged with violating an injunction in the PULLMAN STRIKE of 1894. In 1907 he won acquittal for the radical labor leader William ("Big Bill") HAYWOOD on a charge of conspiring to murder a former governor of Idaho.

A bitter foe of capital punishment, Darrow defended more than 50 accused murderers, losing only one to the executioner. One of his most celebrated trials was that of the young thrill-murderers Nathan Leopold and Richard Loeb, for whom he obtained life sentences instead of death. Equally celebrated was his unsuccessful defense in the 1925 SCOPES TRIAL in Tennessee, in which the agnostic Darrow skillfully fenced with the fundamentalist William Jennings BRYAN over the biblical evidence against evolution.

The American lawyer Clarence Darrow defended the underdog in controversial political and criminal cases. Among his famous clients were the labor leaders Eugene Debs and William Haywood. Darrow is perhaps best known for his defense, in the Scopes case (1925), of the teaching of Darwin's theory of evolution.

Dart, Raymond The South African anatomist Raymond Arthur Dart, b. Toowong, Brisbane, Australia, Feb. 4, 1893, d. Nov. 22, 1988, was the first to identify remains of AUSTRALOPITHECUS, an extinct hominid ancestral to modern humans. The Taung skull, as the fossil is called, was discovered (1924) in a limestone quarry in South Africa; Dart named it *Australopithecus africanus*. He found additional australopithecine remains at Makapansgat.

darter Darters are TELEOST fish belonging to the family Percidae, order Perciformes, a group that includes true PERCHES, walleyes, and saugers. Darters are small bottom-dwelling fish and rarely exceed 10 cm (4 in) in length. They have elongate bodies, and breeding males of some species are among the most colorful freshwater fish. Darters occur only in temperate North America east of the Rocky Mountains. There are three genera: *Amnocrypta*, a small genus whose members are known as sand darters; *Percina*, which includes the log perches; and the largest genus, *Etheostoma*, which has more than 80 species.

Dartmoor Dartmoor is a plateau region in south Devon, southwestern England. It covers 945 km^2 (365 mi^2) and has an elevation of about 518 m (1,700 ft); the highest point is High Willhays at 621 m (2,039 ft). This wild area of moors, granite outcroppings, deep valleys, and peat bogs is the source of most Devon rivers. Dartmoor Forest—of dwarf oaks—is at its center. Dartmoor National Park (established 1951) preserves much of the area. Dartmoor Prison, at Princetown, was built in 1806 to house prisoners of the Napoleonic Wars.

Dartmouth [dahrt'-muth] Dartmouth, a city in south central Nova Scotia, Canada, has a population of 65,243 (1986). It sits on the eastern side of Halifax Harbor, across from Halifax. Settled by the English in 1750, the town became a whaling port in the late 18th century. The completion of the Shubenacadie Canal (1861), from Halifax Harbor to the Bay of Fundy, assisted the area's economic growth. In 1961 eight neighboring communities were added to Dartmouth. The city, which is linked to Halifax by a suspension bridge and ferry service, is an industrial center. The economy is based on oil, shipbuilding, and iron.

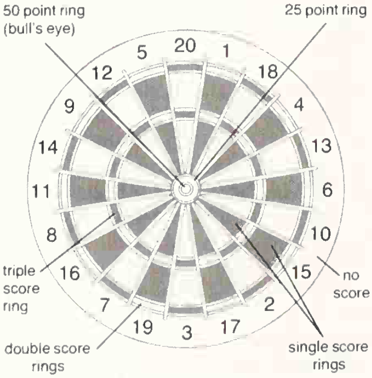
Dartmouth College Established in 1769 by a charter from King George III, Dartmouth College is a liberal-arts institution in Hanover, N.H. A member of the Ivy League, it is now coeducational. Dartmouth has graduate schools of business administration and engineering and a school of medicine. Its annual Winter Carnival is a social attraction.

Dartmouth College v. Woodward The case of *Dartmouth College* v. *Woodward* (1819) involved an early interpretation of the contract clause of the U.S. Constitution. In 1816 the New Hampshire legislature amended the original charter of Dartmouth College. The trustees refused to recognize the new legislation and brought suit against William Woodward, the secretary and treasurer of the college, to recover corporate property entrusted to him under the legislation. After losing in the New Hampshire courts, the trustees appealed to the Supreme Court, where their case was argued by Daniel Webster. Chief Justice John Marshall rendered the opinion, adopting many of Webster's arguments. This case was significant because it gave judicial protection against state interference with corporate contracts.

darts Darts is an old English pub game that has gained considerable popularity in many countries, especially the United States. Dart leagues abound, and tournaments are conducted on a regional, national, and international basis. The most famous is the championship sponsored by the English newspaper *News of the World.*

The standard dart board is the clock, or London, board, which measures 45.7 cm (18 in) in diameter and is divided by wires into 20 equal segments numbered 1 to 20, but not in that order. The board is further divided by a double-score ring and a treble-score ring, each 9.6 mm (⅜ in) wide, and the highest score obtainable with one dart is 60 points, scored by throwing a dart into the treble ring of the 20-point segment.

Feathered darts are the most common, and darts used for competition are made in three basic barrel-shapes, the variations occurring in distribution of weight: evenly, along the entire shaft; concentrated in a central bulge; and concentrated forward on the barrel. The feathered flight, or tail, is made from turkey feathers and marketed as a single flight-shaft unit. For decades, brass has been used in the manufacture of darts, but barrels are now available in heavier and denser metals, such as tungsten alloy.



Darts begins with a fixed score from which all subsequent scores are subtracted. The board is divided into 20 sections, each valued at 1 to 20 points. Two narrow, concentric rings double or triple each section's value. The bull's eye in the center is worth 50 points, and the small ring encircling it, 25.

Darvon Darvon, generically known as propoxyphene, is a mild pain-killing drug (see analgesic) that acts by depressing the central nervous system. It is narcoticlike and can be habit forming. Side effects include sedation, nausea, and dizziness. In 1980 the Food and Drug Administration urged physicians not to refill prescriptions for Darvon in an effort to curb its abuse. Overdose or use with alcohol, tranquilizers, or sedatives can cause convulsions and hallucinations.

Darwin Darwin, a major port on the north central coast of Australia, with a population of 66,100 (1984 est.), is the capital city of the Northern Territory. Located on a coastal plain on the Clarence Strait off the Timor Sea, Darwin is the major commercial, transportation, and governmental center of Australia's north. Its major industries are tile and brickmaking, lumbering, and meat-packing. Cattle raising is important in the areas around the city as is the mining of uranium, bauxite, manganese, and iron.

Founded in 1869 as Palmerston, Darwin was renamed for Charles Darwin in 1911. Its growth was spurred by a gold rush in 1930, but the pre–World War II population was still only 1,600 (1938). Japanese bombing nearly destroyed the city in 1942, and American and Australian troops were sent to Darwin to defend the northern coast. Darwin served as Allied headquarters until 1945. On Dec. 24–25, 1974, the city was almost completely destroyed by a cyclone, but rebuilding began almost immediately.

Darwin, Charles Charles Darwin, b. Feb. 12, 1809, d. Apr. 19, 1882, a British naturalist, revolutionized biology with his theory of evolution. He also made significant contributions to the fields of natural history and geology. The theory of evolution, which held that all living species have evolved from preexisting forms, aroused great controversy and brought about a reevaluation of the position of humans in relation to all other living forms.

Early Years

Darwin was born in Shrewsbury, England, the son of Robert Waring Darwin, a physician, and of Susannah Wedgwood, the daughter of porcelainware manufacturer Josiah Wedgwood. He was also the grandson of poet-philosopher-naturalist Erasmus Darwin. Darwin showed little interest in his early education at Shrewsbury School or in medical studies (1825–27) at Edinburgh University. He turned away from becoming a physician after witnessing several operations performed without anesthesia. At the same time he began to be interested in geology and natural history. He was finally sent (1828) to study for the holy orders for the Church of England at Christ Church College, Cambridge University, but had no inclination for the ministry. Instead, his interest in natural history grew. After he received his B.A. degree in 1831, he took an unpaid position as naturalist on a scientific expedition. Darwin embarked on a 5-year voyage on the H.M.S. *Beagle*, which set sail on Dec. 27, 1831, to study the Pacific coast of South America and some Pacific islands as well as to set up navigational stations in the area. Darwin's duties were to study the geology and biology of these areas.

Darwin's Research

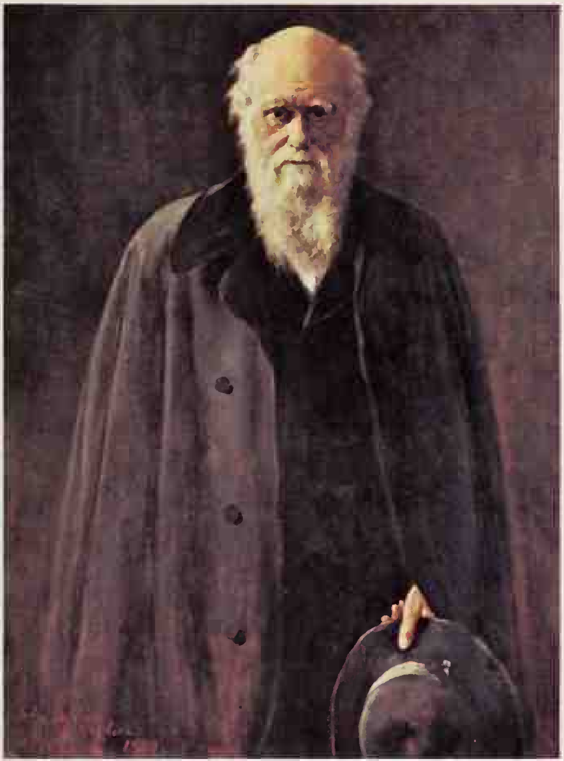
Geology. Although not a trained geologist, Darwin made important discoveries, many of which later provided geological support for some of his ideas on evolution. He noted that sedimentary rock crystallizes when metamorphosed by overlying rock and saw evidence of how volcanoes and earthquakes change the lay of the land, uplifting some areas and sinking others. These and other observations led him to formulate a theory about coral reef formation. Darwin believed that the platforms for existing coral reefs had been built up from the skeletal remains of coral organisms that had died as their home reefs around oceanic mountains gradually sank far below sea level. His geological observations and theories had one thing in common—the idea that things in nature change with time.

Darwin's Finches. The Galápagos Islands were probably the scene of Darwin's most important and best-known research. On these islands, Darwin found a dazzling array of animal life and observed that related but different species lived on different islands even though all the islands were very similar in geological, climatic, and other physical conditions. He found, for example, an array of ground finches with beaks ranging from large and powerful to small or fine. He correlated these differences not with physical conditions on the islands but with the birds' feeding habits. He postulated that each finch was particularly suited to the food available in its environment—an example of what later became known as adaptation. These birds are known today as DARWIN'S FINCHES.

Along the Pacific coast of South America, Darwin observed that closely related species often lived in adjacent geographic areas and that species found on isolated oceanic islands often resembled species found on the nearest continent. Established biological thinking held that all species were unchanging and specially created; however, Darwin found that similar species were always present in adjacent geographic areas. When he discovered, at a given location, fossils of extinct species that were similar to living species, he began to question why similar species existed in successive geologic time periods.

Darwin collected many geologic and biologic specimens, studied many fossils, and made observations of the form, numbers, diversity, and living habits of different forms of life. From his meticulous research he arrived at the idea that species descend, or evolve, from other species.

Darwin's grandfather Erasmus previously had hinted at the idea of evolution, and some geologists contemporary to Darwin had explored the idea that the face of the earth changes over periods of time, but Darwin waited for years after his return to England (1836) to present his conclusions. Even so, he reported on some of the vast amount of data he had accumulated during his trip in the *Journal of Researches* (1839). He also wrote a brief summary of his ideas on evolution that became known to a few scientists, but for the most part Darwin turned to other work, including detailed study of barnacles.



The British naturalist Charles Darwin's theory of evolution, based on natural selection, had a profound effect on the scientific and theological beliefs of his time.

He married a cousin, Emma Wedgwood, in 1839, and lived in London for a while, at which time he was admitted to the Royal Society. In 1842 he settled in Downe, Kent.

On the Origin of Species

In 1856, Darwin began to write his theory of evolution. Before he finished (1858), he received a paper from naturalist Alfred Russel WALLACE outlining a similar theory. Friends arranged for the two men to present a joint paper before the Linnaean Society of London in 1858. On Nov. 24, 1859, an abstract of Darwin's theory was published under the title *On the Origin of Species by Means of Natural Selection, or the Preservation of Favoured Races in the Struggle for Life.*

Darwinism. In this book, Darwin presented his idea that species evolve from more primitive species through the process of NATURAL SELECTION. In his account of how natural selection occurs, known as Darwinism, he pointed out that not all individuals of a species are exactly the same but, rather, that individuals have variations and that some of these variations make their bearers better adapted to particular ecological conditions. He theorized that well-adapted individuals of a species have more chance of surviving and producing young than do the less adapted, and that over the passage of time the latter are slowly weeded out. The accumulation of adaptations to a particular ecological way of life leads—if there is a geographic split of the population—to the development of separate species, each adapted to its own particular ecological living space. It remained for the later science of GENETICS to provide an explanation for this process.

Impact. *On the Origin of Species* was very controversial. The book upset many established patterns of thought, contradicted firmly held religious tenets, and brought into focus the concept that humans are one species among many that have evolved from a more primitive one.

One of the book's greatest effects was the spur it gave biological research. Scientists in all fields of biology pursued research to substantiate or refute Darwin's ideas. Darwin's basic ideas spread to other disciplines, too, although sometimes in a form not true to the original concept, such as the so-called SOCIAL DARWINISM that encouraged a ruthless interpretation of "survival-of-the-fittest" ideas. EUGENICS, a term coined by Darwin's relative Sir Francis GALTON to describe controlled improvement of species, including humans, was also based on Darwin's premises.

Darwin continued to write and to do research, expanding ideas presented in *On the Origin of Species*. In *The Descent of Man and Selection in Relation to Sex* (1871), he provided evidence for human evolution from more primitive species and discussed the role of sexual selection in evolution. His later studies were devoted to plants. Upon his death in 1882, Darwin was buried in Westminster Abbey.

Darwin, Erasmus Erasmus Darwin, b. Dec. 12, 1731, d. Apr. 18, 1802, an English physician and poet, advanced early ideas on EVOLUTION. Unconventional and a freethinker, Darwin expressed through poetry his strong interest in science. In the poem *The Botanic Garden* (1789) he described the classification system of LINNAEUS, and in *Zoonomia* (1794–96) he advanced the idea that the environment directly influences the evolution of an organism. His work was largely overshadowed by that of his grandson Charles DARWIN, who developed the theory of evolution that stated that species evolve by NATURAL SELECTION. Another grandson, Sir Francis GALTON, founded EUGENICS.

Darwinism see DARWIN, CHARLES; EVOLUTION; HEREDITY

Darwin's finches Darwin's finches are a group of 14 related species of finch discovered by Charles Darwin on the Galápagos Islands, each species slightly different from the others and none similar to the mainland finches. Seeing this diversity of types in one small, related group of birds, Darwin wondered whether they were descended from a single early species. These observations helped him formulate the theory of evolution. Darwin's finches are short-tailed members of the subfamily Geospizinae, family Fringillidae. They differ from each other primarily in shape and size of the bill. Males of most species are at least partly black; females are grayish brown. They usually lay four eggs in domed nests that are built in cacti and shrubs. The woodpecker finch, *Camarhynchus pallidus*, uses cactus spines to extract larvae from cacti and trees.

Das Kapital see KAPITAL, DAS

dasyure see HYRAX

data processing see COMPUTER PROGRAMMING; INFORMATION STORAGE AND RETRIEVAL

database A database is a large, complex list of facts and information—usually containing text and numbers, and possibly also images, sounds, and video or film clips. Typical databases include telephone directories, airline flight guides, and bibliographic references. Databases are usually, but not always, constructed on computers. Databases are distinguished from mere lists by one essential feature of their design: upon request, a specific group of disparate facts can be extracted from the full collection.

A database may range from a simple list of names and addresses to a complex labyrinth of interrelated facts and text. Some electronic databases, including computer versions of many reference books, are linked to telephone lines so that people can reach them by dialing through a MODEM and typing the appropriate commands. This type of arrangement is referred to as an online database. The term *database* also refers to database management programs—the computer programs with which people design and construct databases.

Attributes

Every database is designed around a central core list of facts. These facts are grouped in discrete "records," each containing data associated thematically. In a telephone book, each person's entry is one record. Records, in turn, contain "fields," each with a different type of information: in a telephone book, one field is slotted for a last name, another field for a first name, a third for an address, and a fourth for the phone number itself. Fields make an electronic database searchable: anyone can request all records, for example, in which the field for last name contains the word *Jones*. Electronic databases can also be rearranged ("sorted") in the order of fields.

All databases permit users to add new information or to "update" (change) old facts. In paper databases, a new file folder is simply added to the drawer. On computers, new information is entered into an on-screen "form."

To help people retrieve and print facts, databases use reports—commands for sorting lists and formatting their appearance on the printed page. Electronic databases use a "search" or "query" language to help users call forth particular records. Often, the commands incorporate BOOL-

EAN ALGEBRA. For example, requesting all entries with "INDIA" or "INK" will produce entries that contain either term.

Data Structures

Databases basically fit into one of four types of structures, albeit with many variations.

(1) In hierarchical databases, every set of facts belongs to a larger category. An example is the biological classification system (in which a kangaroo is a marsupial and all marsupials are mammals).

(2) Relational (flat-file) databases are analogous to paper charts or tables. This type of database on paper would have one list—say, of animals—running down the left margin of the page and another list—say, of such animal characteristics as habitat, life span, and genus—across the top of the page. In this example there is only one slot for each combination of animal and characteristic.

(3) Multiple-file relational databases are used when information is too complex to fit into a single flat-file table. Multiple-file databases link several tables together. In a database for a library, for example, a single book may relate to several subject categories. A record in a title file of Herman Melville's *Moby-Dick* might require pointers to records in such subject files as Whales, Whaling, New England, Fiction, Obsession, and Quests.

(4) Unstructured databases (also called full-text databases) incorporate information that is too unpredictable and rambling to fit easily into a highly structured form like a relational database. These databases resemble large files of text, with occasional breaks for a new record, like a new chapter in a book.

Usage

Wedding-invitation lists, tax expenses, and names and addresses are examples of some of the many databases kept on home or home-office computers by individuals. Using local-area networks, office workers increasingly tap into each other's databases of budget information and business contacts. One class of database, the EXPERT SYSTEM, presents information on a specialized field.

History and Development

Data management is an extraordinarily old craft. Aristotle's scheme of interlocking classifications of knowledge in his work *Physica* is a data-management effort. The earliest attempts to design computers, such as Charles BABBAGE's analytical engine in the early 19th century, included plans not just to program the machine's actions but to store and sort the data.

In the early 1880s the Jacquard loom used holes punched in paper cards to represent instructions for controlling the action of a loom. These cards became the basis for Herman HOLLERITH's card-sorting device, used for the 1890 U.S. census.

In the 1960s, computers used magnetic tape for storage, which by its nature must be searched sequentially. This was a slow process for a database, which might need to retrieve facts from any part of its system in any order. Nonetheless, databases were increasingly used by large businesses, especially after the American Airlines Sabre system, brought online in 1964, solved the problem of coordinating information about hundreds of daily flight reservations across the continent. Databases for on-line bibliographic retrieval began to appear too.

To make it possible to create databases with customized menus and specialized forms, database management programs emerged, first on mainframes, with their own computer languages (called procedural languages). Beginning in the late 1960s, the programming concepts put forth by database expert Edward Djikstra—that software and data should be created in standard, structured forms so that people could adapt and build on each others' work—achieved wide use, allowing such programs to become increasingly complex.

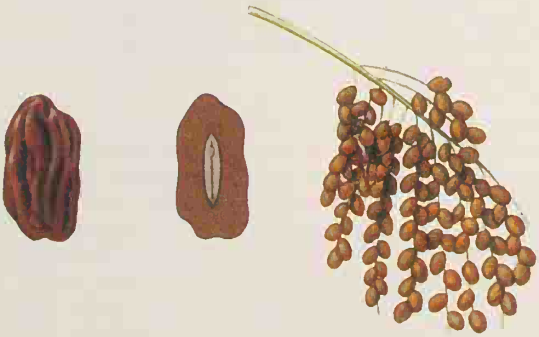
In 1976 computer-software designer Wayne Ratliff created "dBase," a program for building databases on personal computers (see COMPUTER PROGRAMMING).

Outlook

In their early days, databases lacked standardization—data could be moved only between projects created with the same data-management software. That rigidity began to change in the late 1970s. Now it is possible to translate large quantities of data from any program to any other. Query languages—sets of instructions that a user employs to elicit information from a database—are also becoming standard. The Structured Query Language (SQL) has been adopted by many different companies.

date and date palm The date palm, *Phoenix dactylifera*, of the palm family, Arecaceae, has long been a staple carbohydrate food for Arab peoples. Its origins are obscured by its long history in cultivation throughout the Old World arid belt. It does well in dry, hot climates.

P. dactylifera is a tall, unbranched feather palm with a crown of up to 100 leaves. Fruiting occurs after about five years. Loosely branched male and female blossoms grow from the crowns of separate trees, and pollination is encouraged by placing severed male blossoms among the females. Pollen from different males differs in its effects on the fruit's color, size, and ripening qualities. Female



The date palm is cultivated for its fruit, which is an important food crop of the Middle East. The palm has featherlike fronds and bears clusters (far right) *of sweet, chewy fruit.*

blossoms are pruned to ensure that all fruit reaches a reasonable size, and they are often bagged to reduce damage by birds and insects. A good palm may yield more than 90 kg (200 lb) of dates.

Dates are sweet, fleshy drupes, marketed in three categories. Soft dates are harvested when still soft and unripe. Most of the world trade is in soft dates from the Middle East. Semidry dates, from firmer-fleshed cultivars, are also picked before maturity. Deglet Noor, the most important U.S. variety, is of this type. Dry dates, sun-dried on the trees, are eaten in North Africa and Arabia, sometimes softened with milk, often ground as a flour. Arrack, an alcoholic beverage, is made by mixing ground dates and water. Another type of arrack is made from the sap of the tree. The trunk and leaves supply material for rope and basket fibers.

dating see ARCHAEOLOGY; DENDROCHRONOLOGY; GEOLOGIC TIME; RADIOMETRIC AGE-DATING

datura [duh-toor'-uh] *Datura* is the generic name for ten species of annual or perennial herbs, shrubs, or trees belonging to the nightshade family, Solanaceae. Native to tropical and warm temperate regions, mainly in North and Central America (see JIMSONWEED), they have strong-smelling, oval leaves. A few are grown for their large, trumpet-shaped flowers. The common name of these plants, "thorn apple," is derived from the fruits, which are capsules and usually have spines or prickles. The leaves and seeds yield ALKALOIDS such as hyoscyamine, scopolamine, and atropine that have long been used as drugs.

Daubigny, Charles François [doh-been-yee'] Charles François Daubigny, b. Feb. 15, 1817, d. Feb. 21, 1878, was a French landscape painter whose fascination with the play of light in nature anticipated the impressionists. Daubigny was inspired primarily by the countryside of Île-de-France and the waterways of France, particularly the River Oise. He was associated with, but not actually a member of, the Barbizon school. Daubigny advocated painting outdoors as opposed to the traditional practice of completing landscapes in the studio. He even used a boat as a floating studio in order to capture the effects of water, as in *Sunset over the River Oise* (1865; Louvre, Paris), a precedent that would be followed by Claude Monet. Daubigny was an early supporter of the impressionists. After 1838 his paintings were exhibited regularly in the Salons.

Daudet, Alphonse [doh-day'] The French novelist, dramatist, and short-story writer Alphonse Daudet, b. Nîmes, May 13, 1840, d. Dec. 16, 1897, is often associated with the naturalist writers of the second half of the 19th century. He is remembered chiefly for his evocation of provincial life in southern France in such works as *Letters from My Mill* (1870; Eng. trans., 1893), *Tartarin de Tarascon* (1872; Eng. trans., 1875) and *The Woman of Arles* (1872; Eng. trans., 1930).

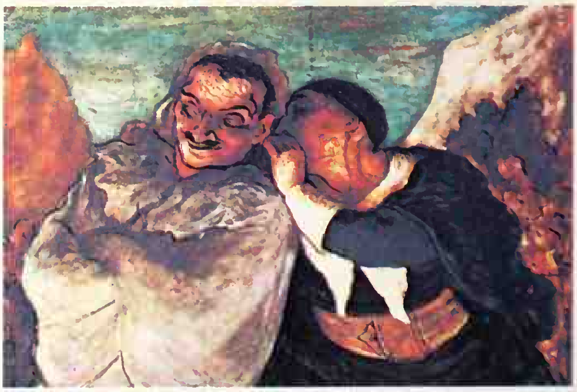
The flavor of Daudet's youth in Provence is captured in the semiautobiographical novel *Le Petit Chose* (1868; *My Brother Jack*, 1877). His novel *Froment the Younger and Risler the Elder* (1874; Eng. trans., 1894) received an award from the Académie Française. In the last years of his life, despite excruciating spinal pain caused by venereal disease, he continued his literary and social life and took an active interest in young writers, including Marcel Proust.

Daugherty, Harry M. [doh'-urt-ee] Harry Micajah Daugherty, b. Washington Court House, Ohio, Jan. 26, 1860, d. Oct. 12, 1941, was appointed (1921) U.S. attorney general by President Warren G. HARDING, whom he had helped to win several elections. While in office, Daugherty was accused of various forms of malfeasance, including participation in the TEAPOT DOME scandal. Forced to resign in 1924, he was twice tried (1927) for conspiring to defraud the government; both trials ended in hung juries. In *The Inside Story of the Harding Tragedy* (1932), which he coauthored, he tried to clear his name.

Daughters of the American Revolution, National Society of the The Daughters of the American Revolution (DAR) is a national U.S. patriotic society founded in 1890 and chartered by Congress five years later. Membership is restricted to direct descendants of people who helped the cause of American independence during the Revolutionary War. Currently, membership totals 208,000; activities include implementing historical, educational, and publications programs.

Daumier, Honoré [dohm-ee-ay', awn-ohr-ay'] Honoré Daumier, b. Feb. 26, 1808, d. Feb. 10, 1879, was a French lithographer, draftsman, painter, and sculptor, best known for his social and political caricatures. In

Crispino and Scapino, *a portrait of two characters from the Comédie Italienne (1858–60), by Honoré Daumier, captures human traits in simple, dynamic forms. (Louvre, Paris.)*



1831, Daumier became a contributor to the satirical journal *La Caricature*. When it was censored by the regime in 1835, he joined the staff of *Le Charivari* and was associated with that journal for the next 30 years. The main subjects of Daumier's satirical cartoons were the corrupt regime, the injustice of the law courts, and the hypocrisy of the middle class. He created universal types and characters personifying all aspects of the "human condition"; his scenes of the low, the humble, the commonplace, and the banal recalled the world reflected in the novels by Honoré de Balzac. Daumier's best-known caricatures include the monumental and popular political drawings *The Legislative Paunch* and *Rue Transnonain, April 15, 1834* (both 1834) and two lithographic series introducing his famous embodiments of all human vices, *Robert Macaire* (1836) and *Ratapoil* (1850).

In the mid-1840s, Daumier turned to painting and sculpture, producing his famous series *Lawyers* and *Third Class Carriage*. His paintings and sculpture, however, are generally considered inferior to his more than 5,000 extant lithographs.

dauphin [daw'-fin or doh-fan'] Dauphin was the title of the heir apparent to the French throne. It was originally a family name of the counts of Viennois, whose lands came to be known as the Dauphiné; it was adopted as a royal title after Dauphiné passed to the crown in 1349. The last dauphin was Louis Antoine, duc d'Angoulême (1775–1844), son of King Charles X.

Dauphiné [doh-fee-nay'] Dauphiné is a historic province of southeastern France, bordered by Italy on the east and the Rhône River on the west. GRENOBLE, the traditional capital, is now the transportation and manufacturing center of the region. Most of Dauphiné is covered by pre-Alpine mountain ranges and the Dauphiné Alps. Agriculture takes place in the Rhône Valley, where cereals, olives, and fruits (including grapes for wine) are produced. Cattle and sheep are raised in the uplands.

The region became part of the kingdom of Arles in 933 and was subsequently a fief of the Holy Roman Empire. In 1349, King Philip VI of France purchased Dauphiné from the counts of Viennois. From 1350 to 1830, Dauphiné was the land grant, and dauphin the title, of the heir to the French throne. After 1790, Dauphiné was divided into the departments of Drôme, Isère, and Hautes-Alpes.

Dausset, Jean [doh-say'] French geneticist Jean Baptiste Gabriel Joachim Dausset, b. Oct. 19, 1916, shared the 1980 Nobel Prize for physiology or medicine with American geneticists George D. Snell (1903–) and Venezuelan-born Baruj Benacerraf (1920–) for their research on the gene complexes that regulate immunological reactions. Dausset obtained his doctorate from the University of Paris in 1943 and did research at Harvard Medical School before joining the staff of the University of Paris in 1958, where he remained until going to the College of France in 1977. In the 1950s, Dausset extended the work of Snell on the major histocompatability complex (MHC) in mouse chromosomes to the corresponding gene structures in human beings, through his research on the antibodies produced by patients suffering from serious blood diseases. His work first defined a human MHC, or human leukocyte ANTIGEN. Such antigens are now all known to be related and to exist in all human tissues.

Davao [dah-vow'] Davao is a city on the southeast coast of Mindanao Island in the Philippines. It is situated on the Gulf of Davao at the mouth of the Davao River. The city has a population of 610,375 (1980) and covers an area of 2,212 km^2 (854 mi^2); it is one of the largest cities in area in the world. The highest point in the Philippines, Mount Apo (2,954 m/9,692 ft), is located within Davao. The climate is tropical.

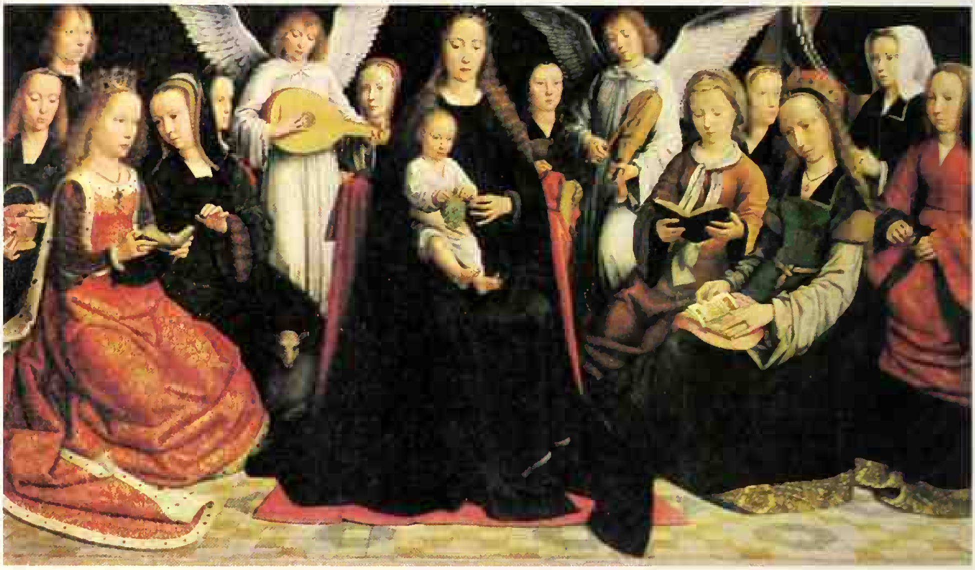
Davao is a busy port, exporting copra, maize, rice, and abaca (banana plant fiber used in rope making). Much of its land is agricultural, with coconuts and rice the predominating crops. The manufacturing of wood products is the major industry. Settled in 1849, the city was completely destroyed by Allied bombing during World War II but was subsequently rebuilt.

Davenport Davenport, a city in east central Iowa on the Mississippi River, is the seat of Scott County and has a population of 95,333 (1990). Connected by bridge with the Illinois cities of Moline, East Moline, and Rock Island, it is the largest of the Quad Cities. Highly industrialized, Davenport manufactures sheet aluminum, iron and steel, airplane parts, tractor parts, processed food, cement, and wood products. St. Ambrose College and Marycrest College are located there. The city was founded (1836) by Col. George Davenport on the site of an Indian village after the Black Hawk War. The first railroad bridge to span the Mississippi was built there in 1856.

David, Gerard [dah'-veet, gay'-rart] The Flemish painter Gerard David, b. *c.*1460, d. 1523, succeeded Hans MEMLING as the leading painter of Bruges. David is generally considered the last of the great Netherlandish primitive artists (see FLEMISH ART AND ARCHITECTURE).

The Judgment of Cambyses (1498; Groeningemuseum, Bruges), two panels conceived as a lesson in justice and executed for the council room of the Town Hall of Bruges, is the first known, dated work by David. In 1509 he donated to the Carmelite Convent at Bruges the painting *Virgin and Child* (1509; Musée des Beaux-Arts, Rouen), in which portraits of the artist and his wife can be seen.

In the formulation of his style, David borrowed elements from almost all the great masters of 15th-century Netherlandish painting; consequently, his paintings are sometimes said to have an archaic feeling about them. It is more likely, however, that he enjoyed painting grand, solemn figures with restrained gestures and emotions and



The Flemish painter Gerard David's Virgin and Child *(1509) combines the northern European tradition of realism with the stable, symmetrical composition characteristic of the Italian High Renaissance. (Musée des Beaux-Arts, Rouen.)*

immobilized in static compositions. Within the northern tradition of REALISM, David's work sometimes suggests the balanced and harmonious painting of the classically oriented Italian Renaissance.

David, Jacques Louis [dah-veed'] Jacques Louis David, b. Aug. 30, 1748, d. Dec. 9, 1825, was the greatest proponent of strict NEOCLASSICISM in French painting during the Revolutionary and Napoleonic eras. His style became austere, intimately allied to the forms of ancient art and to a profound belief in art's moral purpose.

David's first masterpiece, *The Oath of the Horatii* (1784; Louvre, Paris), established his reputation. This painting epitomizes the neoclassical style in the historical accuracy of its costumes and setting, the shallow friezelike space in which the action occurs, the restrained emotional expression, and the avoidance of painterly execution. These were to be the primary characteristics of David's subsequent painting, in which the subject often was derived from Greek and Roman history. The qualities of dignity, noble courage, and moral virtue pervaded David's later paintings.

David was a staunch supporter of the Revolution, becoming personally involved in events as director of artistic affairs. He produced several major contemporary historical works, the most famous of which is *The Death of Marat* (1793; Musées Royaux des Beaux-Arts, Brussels), painted in the same year Charlotte Corday assassinated Jean Paul Marat in his bath. David won favor again under Napoleon, becoming his principal painter. His finest portraits include several of Napoleon himself, for example, *Napoleon in His Study* (1812; National Gallery of Art, Kress Collection, Washington, D.C.).

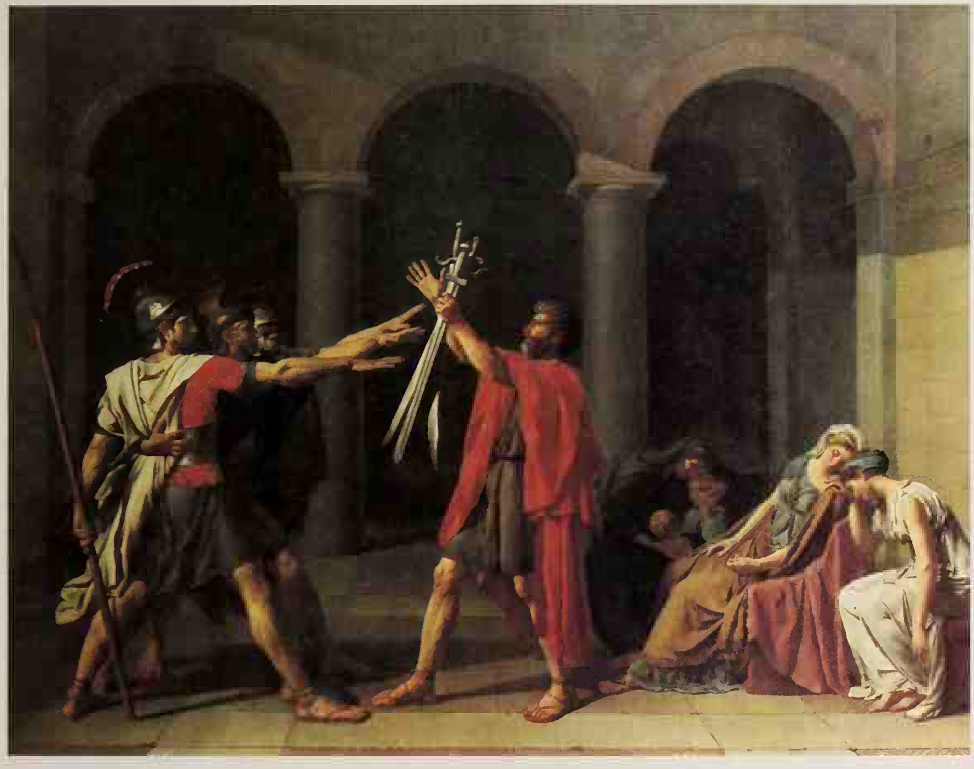
David gathered around him a group of artists who called themselves the Primitives, pushing to further extremes than any other neoclassicists in Europe the desire for an austere purity in art. In reaction to the excesses of the baroque, the Primitives went so far as to dismiss all art of the past except Greek vase paintings and the earliest ancient sculptures and all architecture with the exception of Greek Doric temples.

After Napoleon was exiled from France, David also went (1816) into exile to Belgium, where he died.

David, King of Israel David, d. *c.*961 BC, was the second and probably the most famous king of ancient Israel (1002–962). His long career, beginning with his tortuous climb to power, is described in the Old Testament books 1 Samuel 16–31, 2 Samuel, and 1 Kings 1–2. David entered the service of SAUL, Israel's first king, but Saul's jealousy finally forced him to flee. He sought refuge first as a bandit leader, then as a Philistine mercenary. After Saul's death, David returned to Hebron where he was appointed king over Judah and, several years later, following a long civil war with Saul's heir, over Israel.

David consolidated his power in Jerusalem, which he made the political and religious capital of his kingdom. Although God did not permit him to build a temple, he promised David an eternal dynasty in Jerusalem. This promise and the religious ideology that informed David's successful imperial expansion were the sources of Israel's later hope for a MESSIAH. The latter part of David's reign was marred by family problems and numerous revolts, two led by his own sons. The Bible portrays these evils as the bitter fruit of his adulterous affair with BATHSHEBA. David was forgiven, however, and the son that succeeded him was Bathsheba's child, SOLOMON.

David was also an accomplished musician. Late tradition credits him with organizing the temple choirs and attributes many of the PSALMS to him.



The severe, dramatic style of Jacques-Louis David's neoclassical Oath of the Horatii *(1784) is a reaction against the frivolous French rococo style by extolling republican values. (Louvre, Paris.)*

David, Saint Saint David, fl. 6th century, is the patron saint of Wales. He founded a monastery at Menevia (Mynyw), now St. Davids, and established many churches throughout Wales. His shrine at Menevia was a popular place of pilgrimage in the Middle Ages. Most of the details of his life are legendary. Tradition holds that he urged the Welsh warriors to wear leeks to distinguish themselves from their Saxon opponents in battle, a custom still followed by the Welsh on his feast day, March 1.

David Copperfield The semiautobiographical *David Copperfield* (1849–50), which takes its hero from orphaned childhood to final fulfillment in marriage and career by way of a variety of trials and false starts, is probably Charles DICKENS's most memorable novel. From a cruel stepfather, a vicious headmaster, and menial degradation as a boy laborer in London, David is rescued by his great-aunt Betsey Trotwood. He is then apprenticed to a lawyer, Mr. Wickfield, whose daughter Agnes befriends him. David marries the childish, irresponsible Dora, but does not find real happiness until after Dora's death, when he realizes he has always loved Agnes. Known and loved as much for its comic portraiture as for its universally appealing plot, *David Copperfield* introduces such unforgettable secondary characters as the eternally optimistic but always indebted Mr. Micawber, the unctuous Uriah Heep, the ever "willin' " Barkis, the eccentric Peggotty family, and the reckless Steerforth and reliable Traddles. In recording David's earliest experiences, Dickens also laid bare the abusive treatment of poor children that characterized Victorian England.

David I, King of Scotland David I, b. *c.*1084, d. May 24, 1153, king of Scotland (1124–53), reorganized the Scottish kingdom along Norman lines. The youngest son of MALCOLM III and his English queen, Saint MARGARET OF SCOTLAND, he was educated in Norman England, where his sister Edith had married King HENRY I. As king, David intervened in English affairs to aid his niece, Queen MATILDA, against King STEPHEN but was defeated at the Battle of the Standard near Northallerton in 1138.

During David's reign Normans and Flemings settled in Scotland, and such institutions as the sheriffdom, the justiciary, and the jury were developed.

Davidson, Jo The American sculptor Jo Davidson, b. New York City, Mar. 30, 1883, d. Jan. 2, 1952, is noted for his portraits of prominent 20th-century people. Davidson, who studied briefly at the Art Students League of New York and the École des Beaux-Arts, Paris, worked in a naturalistic style that conveyed the personality of the subject. He portrayed such diverse individuals as Mahatma Ghandi, Franklin D. Roosevelt, Albert Einstein, James Joyce, George Bernard Shaw, Benito Mussolini, and

Helen Keller. Among his most famous works is a bronze sculpture of *Gertrude Stein* (1920; Whitney Museum of American Art, New York City). His autobiography, *Between Sittings*, was published in 1951.

Davidson College Established in 1837, Davidson College is a 4-year coeducational liberal arts school in Davidson, N.C. It is affiliated with the Presbyterian Church in the United States.

Davies, Arthur B. Arthur Bowen Davies, b. Utica, N.Y., Sept. 26, 1862, d. Oct. 24, 1928, was an American painter best remembered for his leadership in organizing the ARMORY SHOW of 1913. It was largely through his efforts that this famous exhibition, which opened in New York City and traveled to Chicago and Boston, gave the United States its first extensive contact with modern painting and sculpture. Davies's own best works, painted in the style of *The Dream* (1909; Metropolitan Museum of Art, New York City), with its fairy-tale landscape and surreal atmosphere, stand well within the American romantic tradition. Davies was one of The Eight, a group of New York City artists led by Robert HENRI in the first decade of the 20th century and the nucleus of the ASHCAN SCHOOL. After the Armory Show, Davies's style shifted for a time to a decorative interpretation of CUBISM.

Davies, Sir John Sir John Davies, b. Apr. 16, 1569, d. Dec. 8, 1626, was an English poet best known for his philosophical poems *Nosce Teipsum* (1599) and *Orchestra, or A Poem on Dancing* (1596). Davies served as attorney general for Ireland under James I and was a founder of the Society of Antiquaries.

Davies, Robertson Robertson Davies, b. Thamesville, Ontario, Aug. 28, 1913, one of Canada's leading cultural figures, writes essays and plays but is primarily known for his three trilogies. The Deptford Trilogy, his second and most famous, consists of *Fifth Business* (1970), *The Manticore* (1972), and *World of Wonders* (1975). *The Rebel Angels* (1982), *What's Bred in the Bone* (1985), and *The Lyre of Orpheus* (1989) constitute the third. Much of his fiction is influenced by the writings of psychiatrist Carl Jung. Davies taught English at the University of Toronto until 1981.

Davies, Samuel A Presbyterian minister, Samuel Davies, b. Nov. 3, 1723, d. Feb. 4, 1761, was a major leader of the GREAT AWAKENING in the American colonies. His ministry in Virginia led to the expansion of the Presbyterian church in the South. Davies's successful struggle for the religious freedom of Dissenters in the Anglican colony was an important step toward complete toleration. In 1759 he was appointed president of the struggling young College of New Jersey (now Princeton University).

Davis, Alexander Jackson The architect Alexander Jackson Davis, b. New York City, July 4, 1803, d. Jan. 14, 1892, in partnership with Ithiel Town, designed public buildings and large private houses in the GREEK REVIVAL style that became a hallmark of mid-19th-century American architecture. Among their most famous works were the old New York Custom House (1832–42) and the old Illinois State Capitol at Springfield (1837–41). After Town's death in 1844, Davis continued to design large buildings, but it was as an architect of "picturesque" Gothic country houses that he became best known. These ranged from large castlelike villas such as Lyndhurst (1838–65) in Tarrytown, N.Y., to "cottages" like the Nicholls house (1858–59) in Llewellyn Park, N.J.

Davis, Benjamin O. Benjamin Oliver Davis, b. Washington, D.C., June 1, 1877, d. Nov. 26, 1970, was the first African American to become (1940) a general in the U.S. Army. He had previously served (1911–12) as military attaché in Liberia. He also taught military science at Wilberforce University and Tuskegee Institute between 1905 and 1938. His son, Benjamin Oliver Davis, Jr., b. Dec. 18, 1912, serving in the U.S. Air Force, became the first black to attain the ranks of major general (1959) and lieutenant general (1965) in the U.S. armed forces.

Davis, Bette Bette Davis is the stage name of Ruth Elizabeth Davis, b. Lowell, Mass., Apr. 5, 1908, d. Oct. 6, 1989, for many years one of Hollywood's most popular actresses. Known for her striking looks, distinctive voice, and outspoken opinions, Davis won Academy Awards as best actress in *Dangerous* (1935) and *Jezebel* (1938). Acclaimed among her many other performances were her

Bette Davis (right) *appears with Celeste Holm in this scene from the 1950 film* All About Eve. *In a long, successful film career, Davis often portrayed emotionally intense women, as in* The Old Maid *(1939) and* The Little Foxes *(1941).*

roles in *Of Human Bondage* (1934), *Elizabeth and Essex* (1939), *The Little Foxes* (1941), *Watch on the Rhine* (1943), and *All About Eve* (1950). Davis's later work includes two campy horror films, *Whatever Happened to Baby Jane?* (1962) and *Hush, Hush, Sweet Charlotte* (1965). In *The Whales of August* (1987) she costarred with Lillian Gish. Davis appeared in many television films and remained active until her death.

Davis, Sir Colin Colin Davis, b. Sept. 25, 1927, is an English conductor particularly admired for his interpretations of Mozart and Berlioz. He began his career as a clarinetist in London orchestras. He made his conducting debut (1961) in the United States with the Minneapolis Symphony and his Metropolitan Opera debut (1967) conducting Benjamin Britten's *Peter Grimes.* Since 1971, Davis has been musical director at Covent Garden. He has served as principal guest conductor of the Boston Symphony since 1972. Davis was knighted in 1980.

Davis, David David Davis, b. Cecil County, Md., Mar. 9, 1815, d. June 26, 1886, was a justice of the U.S. Supreme Court and a U.S. senator. As an Illinois lawyer and circuit-court judge, he became a close friend of Abraham Lincoln and managed Lincoln's campaign for the Republican presidential nomination in 1860. In 1862, Lincoln appointed Davis to the U.S. Supreme Court. Davis wrote the important Ex parte Milligan decision of 1866, which limited the use of military authority over civilians in areas far from combat. In 1872 he was nominated for the presidency by the Labor Reform party, but he withdrew when he did not receive the endorsement of the Liberal Republican Party. In 1877, Davis resigned from the Court to serve a term (1877–83) as senator from Illinois.

Davis, Elmer Elmer Holmes Davis, b. Aurora, Ind., Jan. 13, 1890, d. May 18, 1958, a news analyst and radio commentator, was noted for his incisive reporting of World War II and the clear, blunt style with which he analyzed complex postwar issues.

Davis spent 10 years as a reporter with the *New York Times* (1914–24). His *History of the New York Times* (1921) was followed by several novels, short stories, and essay collections. During World War II he was a news analyst and commentator for CBS radio (1939–42) and then served as director (1942–45) of the Office of War Information. He was a news analyst for ABC from 1945 to 1956.

Davis, Frank Marshall A journalist and author, Frank Marshall Davis, b. Arkansas City, Kans., Dec. 31, 1903, d. July 26, 1987, was well known among African Americans for the cutting irony of his poetry. Davis's childhood in the small town of Arkansas City was marred by the pervasive racism of the place. He escaped to a lifelong career as a writer and editor for African-American publications, most notably the *Atlanta* (Ga.) *World*, which he helped make the country's first successful African-American daily. *Black Man's Verse* (1935), Davis's acclaimed first published poetry collection, was compared with Whitman's and Sandburg's works. Later volumes are *I Am the American Negro* (1937), *47th Street* (1948), and *Jazz Interlude* (1985).

Davis, Glenn Glenn Davis, b. Claremont, Calif., Dec. 26, 1924, is a former football player who starred at the U.S. Military Academy as a freshman in 1943 and during West Point's undefeated seasons of 1944, 1945, and 1946. He scored 3, 20, 18, and 13 touchdowns, respectively, in those seasons. During the last three seasons he was known as Mr. Outside, part of a backfield tandem with Felix "Doc" Blanchard (Mr. Inside). Between them, from 1944 to 1946, they scored 89 touchdowns. An outstanding all-around athlete and football player, Davis won the Heisman Trophy as a senior. After fulfilling his military commitment, he played professionally for the Los Angeles Rams in 1950–51.

Davis, Henry Winter Henry Winter Davis, b. Annapolis, Md., Aug. 16, 1817, d. Dec. 30, 1865, was a U.S. political leader who served (1855–61, 1863–65) as a congressman from Maryland. Between his terms in Congress he campaigned successfully in Maryland to keep that state in the Union. In Congress, Davis and Senator Benjamin F. Wade attacked President Abraham Lincoln's Reconstruction policy and pushed through both houses their own more radical program, proposing congressional control over Reconstruction. Lincoln's pocket veto (1864) killed the bill. Its sponsors responded with the Wade-Davis Manifesto (Aug. 5, 1864), criticizing Lincoln for exceeding his constitutional powers by usurping Congress's legislative authority.

Davis, Jefferson As the only president of the Confederate States of America, Jefferson Davis, b. Christian (now Todd) County, Ky., June 3, 1808, d. Dec. 6, 1889, struggled to lead the Confederacy to independence in the U.S. Civil War. Davis grew up in Mississippi and entered West Point in 1824. After graduation in 1828, Davis served at frontier military posts and in the Black Hawk War before resigning in 1835.

Davis's first wife, Sarah Knox Taylor, daughter of Zachary Taylor, died in September 1835, three months after their marriage. Heartbroken over her death, Davis moved to an isolated Mississippi plantation close to that owned by his brother Joseph. There he spent 10 years managing the plantation and studying. In 1845 he married Varina Howell, and in the same year he was elected to the U.S. House of Representatives as a Democrat. Davis soon left (1846) to command Mississippi troops in the Mexican War. He was prominent in the Battle of Buena Vista (February 1847), where he was wounded. After the war, he was appointed (August 1847) a U.S. senator from Mississippi, but he resigned in 1851 to make an

Jefferson Davis was the only president of the Confederacy. The most prominent Southern statesman of his time, Davis was selected as chief executive in February 1861. He was captured at the end of the Civil War and spent 2 years in a federal prison.

unsuccessful campaign for governor of Mississippi. He was an outstanding secretary of war (1853–57) in the cabinet of Franklin Pierce, and then returned to the Senate, where he became a spokesperson for the South.

Basically a moderate, Davis favored Mississippi's secession and hoped to be made commander of the Southern army. Instead, he was elected president of the Confederacy and inaugurated on Feb. 18, 1861. For the next 4 years Davis gave his complete devotion to the Southern cause, but he was far from an ideal chief executive. His greatest weakness was his inability to get along well with people. He was stiff and formal, unwilling to concede small points to win large objectives. As a result, he quarreled long and often with Confederate congressmen, generals, governors, and the press.

Largely because of these limitations, Davis lacked popular appeal. He was unable to win wholehearted cooperation for such unpopular but necessary measures as conscription, the impressment of supplies, and suspension of the writ of habeas corpus. Nor was he able to deal with such problems as refugees, inflation, and the shortage of necessities. He became increasingly unpopular as the war continued.

In fairness, it must be said that the winning of Southern independence was probably impossible. Much of the opposition to him came from short-sighted men who put personal status or their state's interests above the cause of the Confederacy, or from honest men who were unable to understand that successful modern war demands the sacrifice of some state rights and personal liberties to the common cause.

In April 1865, as the Confederacy was collapsing, Davis fled from Richmond, Va., hoping to continue the war from the Deep South or from west of the Mississippi, or to organize a government in exile. On May 10 he was captured by Federal cavalrymen in southern Georgia. For 2 years he was held in prison and threatened with trial for treason. His suffering during his imprisonment won him the affection of the Southern people, who came to regard him as a martyr to their lost cause. Although indicted, Davis was never brought to trial, and he was released on bond in 1867. Believing that he had done nothing to be pardoned for, he refused to seek a pardon and remained ineligible for public office. Davis was saved from poverty by a generous family friend whose wealth permitted the ex-president to retire to his home near Biloxi, Miss., and devote himself to writing in defense of the South in general and himself in particular. His *Rise and Fall of the Confederate Government* was published in 1881. Davis died in New Orleans, La.

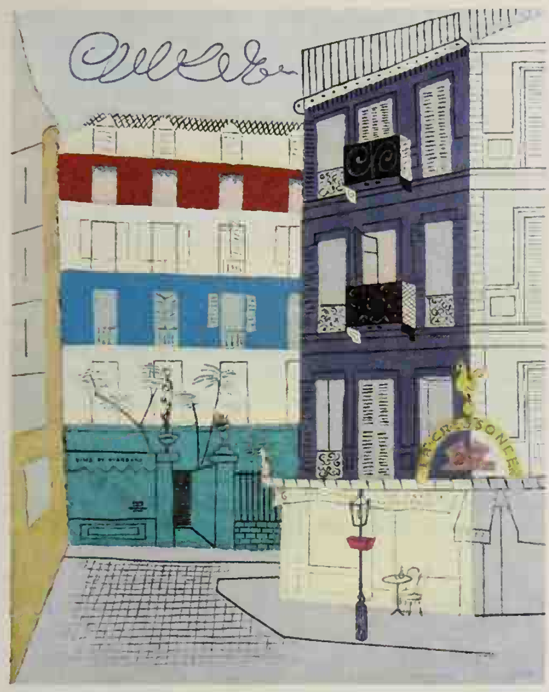
Davis, John W. John William Davis, b. Clarksburg, W. Va., Apr. 13, 1873, d. Mar. 24, 1955, was an American lawyer and candidate for president. Davis was a U.S. representative from West Virginia (1911–13), U.S. solicitor general (1913–18), and U.S. ambassador to Britain (1918–21).

Davis was nominated for the presidency on the 103d ballot at the 1924 Democratic convention, ending a two-week deadlock between the supporters of Alfred E. Smith and William G. McAdoo. Badly defeated by incumbent Calvin Coolidge, Davis went on to become a leading constitutional expert. He argued against school desegregation in the case of Brown v. Board of Education of Topeka, Kansas (1954).

Davis, Miles Miles Dewey Davis, Jr., b. Alton, Ill., May 25, 1926, d. Sept. 28, 1991, was a jazz trumpeter, composer, and bandleader. He helped establish several important jazz styles. He joined Charlie Parker's bebop band in 1945. In 1949–50 his small jazz group made some of the first "cool" jazz records. In 1954, Davis's recording "Walkin" initiated the hard-bop style that dominated black jazz for several years. In his later music he played amplified trumpet in a style that combined jazz and rock. Davis's influence cannot be overestimated.

Davis, Ossie Ossie Davis, b. Cogdell, Ga., Dec. 18, 1917, is an American actor, playwright, and civil rights activist best known for writing and starring in *Purlie Victorious* (1961). Davis won an Emmy in 1969 for his performance in the television drama *Teacher, Teacher*, and he directed the 1970 film *Cotton Comes to Harlem*. He continues to work, especially in television.

Davis, Stuart Stuart Davis, b. Philadelphia, Dec. 7, 1894, d. June 24, 1964, was a leading American painter, cartoonist, illustrator, and art theorist. The 1913 Armory Show, in which he exhibited five watercolors, introduced Davis to European avant-garde art, which became the major influence of his formative years. Around 1915 he broke with the Ashcan realist idiom and began to introduce in his work elements of postimpressionism, such as in *Hillside near Gloucester* (1915–16; Museum of Fine Arts, Boston), which displays a broad stylization of form and nonimitative use of color. A number of abstractions, such as *The President* (1917; Munson-Williams-Proctor Institute, Utica, N.Y.), and experiments with collage followed.



In Place Pasdeloupe *(1928), an early painting by the American artist Stuart Davis, the elements of a Parisian street are reduced to black outlines against flat planes of color. (Whitney Museum of American Art, New York.)*

Davis's works of the 1920s show the influences of cubism, futurism, and the mechanistic style of Fernand Léger. They are characterized by generalized form with the subject conceived as a series of planes defined as flat geometric shapes organized into planar compositions. Davis often made use of words and lettering to emphasize the flatness of the picture surface. This practice later evolved into the device of using words to function as abstract shapes, as in *Visa* (1951; Museum of Modern Art, New York City) and *Première* (1957; Los Angeles County Museum of Art).

Davis, William Morris William Morris Davis, b. Philadelphia, Feb. 12, 1850, d. Feb. 5, 1934, was an American geographer. While on the faculty of Harvard University (1876–1912), Davis was responsible for raising the study of geology and physiography to a discipline, and for institutionalizing the study of geography in the United States. He founded (1904) the Association of American Geographers. Davis urged his students to study humans in relationship to their physical environment.

Davis Strait Davis Strait is a channel of the Atlantic Ocean between southwestern Greenland and southeastern Baffin Island. It is named for the navigator John Davis, who explored it in 1585 and 1587. About 645 km (400 mi) long and 320–645 km (200–400 mi) wide, it is ice-covered from late fall until July. The warmer West Greenland Current sweeps up its eastern side, and the Labrador Current flows south along its western side.

Davitt, Michael [dav'-it] Michael Davitt, b. Mar. 25, 1846, d. May 31, 1906, a leader of the Irish Republican Brotherhood, called the Fenians, was a principal founder of the National Land League in 1879. Representing an alliance between the republicans and the constitutional nationalists led by Charles Stewart Parnell, the league organized Irish tenant farmers in mass resistance to eviction. Its activities helped lead to the Land Act of 1881, which established the "three Fs"—fair rent, fixity of tenure, and freedom of sale—long demanded by Irish land reformers.

Davos [dah-vaws'] Davos (1985 est. pop., 10,200) is a resort town in Grisons canton, eastern Switzerland, 16 km (10 mi) from the Austrian border. Lying at an elevation of 1,529 m (5,015 ft), it comprises two villages: Davos-Platz and Davos-Dorf. From the mid-19th century, Davos was a health resort primarily for tuberculosis treatment; today it is chiefly known for its skiing. First mentioned in written records during the 12th century, Davos was part of Austria from 1477 to 1649.

Davout, Louis Nicolas [dah-voo'] A French marshal, Louis Nicolas Davout, b. May 10, 1770, d. June 1, 1823, fought for the French revolutionaries and Napoleon I despite his aristocratic birth. He accompanied Napoleon to Egypt in 1798–99 and contributed to his victories in central Europe from Austerlitz to Wagram (1805–09). He was created duc d'Auerstädt in 1808 and prince d'Eckmünl the following year.

Later, Davout fought in the Russian campaign, governed Hamburg, and was war minister during the Hundred Days (after Napoleon's return from exile) in 1815. He swore allegiance to the restored Bourbon dynasty in 1817.

Davy, Sir Humphry The English chemist Sir Humphry Davy, b. Dec. 17, 1778, d. May 29, 1829, invented the safety lamp for miners and was the first to apply electrical current to isolate alkali metals and alkaline earth metals. In 1800, Davy published a description of the effects of nitrous oxide (laughing gas) and an account of his nearly fatal inhalation of water gas, a mixture of hydrogen and carbon monoxide. In 1801, Davy was appointed to the then newly established Royal Institution as lecturer, and in 1802 he was advanced to professor. Davy's chemistry lectures and demonstrations were brilliantly presented and became a fashionable social event.

Davy used electrolysis to obtain elemental potassium and sodium in 1807 and calcium, strontium, barium, and magnesium in 1808. He obtained boron simultaneously with Joseph Louis GAY-LUSSAC. He also showed that oxygen could not be obtained from the substance known as oxymuriatic acid and proved it to be an element, which he named chlorine.

See also: CHEMISTRY, HISTORY OF.

Dawes, Charles G. Charles Gates Dawes, b. Marietta, Ohio, Aug. 27, 1865, d. Apr. 23, 1951, was a banker and vice-president (1925–29) of the United States. During World War I he was the chief purchasing agent for the United States. President Warren G. Harding appointed Dawes the first director of the Bureau of the Budget in 1921. In 1923, when the German economy collapsed, he chaired the Committee of Experts of the Allied Reparations Commission, which instituted the Dawes Plan to restore and stabilize the German economy and allow the gradual payment of German REPARATIONS to former enemies. He shared the 1925 Nobel Peace Prize for this work.

As vice-president, Dawes supported the KELLOGG-BRIAND PACT (1928), and as ambassador to Britain (1929–32), he participated in international efforts to limit naval armaments and settle the Sino-Japanese crisis of 1931. In 1932, President Herbert Hoover appointed Dawes to head the Reconstruction Finance Corporation, which lent federal funds to bolster the sagging economy.

Dawes, William William Dawes, b. Boston, Apr. 6, 1745, d. Feb. 25, 1799, was an American patriot who, on Apr. 18, 1775, set out with Paul REVERE and Samuel Prescott on the ride from Lexington to Concord, Mass., warning the countryside that the British were coming. Revere was captured en route, and Dawes turned back, but Prescott continued the ride.

Dawes Act The Dawes Severalty Act, passed by the U.S. Congress in 1887, stipulated that American Indians give up their tribal lands in return for individual land grants. Sponsored by Senator Henry Laurens Dawes, it was intended to promote the integration of the Indians into the homesteading way of life. Its main effect was to open up the INDIAN TERRITORY to white settlers.

day A day is a period of 24 HOURS. The length of the hour is determined by the length of the day, and the length of the day is defined in astronomical terms. That is, the time interval from when the Sun or a given star passes directly overhead, to when it next passes directly overhead, is defined as one solar day or one sidereal day, respectively. Because of the Earth's orbital motion, the Sun appears to move eastward nearly 1° (about 0.986°) each day, on the average, with respect to the stars. This means that the apparent solar day averages about 3 min 56 sec longer than the sidereal day.

Apparent solar days are not of equal length on Earth, however, because of the tilt of the Earth's axis and the Earth's variable orbital speed. Two successive apparent solar days can vary by as much as 30 sec. For that reason, when clocks and watches came into general use, *mean solar time* was introduced for civil purposes. A mean solar day has the average length of all the apparent solar days that make up a year. The difference between apparent and mean solar time, known as the equation of time, reaches a maximum of about 16.3 min on or about November 1.

Precise astronomical observations have indicated variations in the lengths of the sidereal day and the mean solar day. The length of a mean solar day, as judged by the modern ATOMIC CLOCK, increases about 0.0015 sec each century. Irregular increases or decreases in rotational speed over intervals of several years have also been observed. Quartz-crystal clocks have indicated annual variations of up to 0.03 sec due to seasonal changes in winds and tides.

See also: CALENDAR; EARTH, MOTIONS OF; YEAR.

Day, Benjamin Henry Benjamin Henry Day, b. West Springfield, Mass., Apr. 10, 1810, d. Dec. 21, 1889, was founder of the *New York Sun*. After working on the *Springfield* (Mass.) *Republican* under Samuel Bowles, Day left for New York in 1831 and in 1833 started the *Sun* as the first penny daily. His papers, marketed by newsboys on the street—a Day innovation—soon outsold all others. By 1835, Day claimed a circulation of 19,360—the world's largest.

Day, Clarence The American essayist, illustrator, and humorist Clarence Shepard Day, Jr., b. New York City, Nov. 18, 1874, d. Dec. 28, 1935, is best known as the author of *Life with Father* (1935), an irreverent but fond reminiscence of his eccentric father. Howard Lindsay and Russel Crouse's 1939 stage adaptation, with additional material from *God and My Father* (1932) and *Life with Mother* (1937), ran for 17 years on Broadway.

Day, Dorothy Dorothy Day, b. Brooklyn, N.Y., Nov. 8, 1897, d. Nov. 29, 1980, was a Roman Catholic social activist and journalist who helped found the Catholic Worker movement in 1933. Before her conversion to Roman Catholicism in 1927, she wrote for socialist and Communist publications. In 1933 she and writer Peter Maurin (1877–1949) founded the *Catholic Worker*, a paper that addressed itself to social problems based on the ethical teachings of the New Testament. Day also devoted herself to organizing hospitality houses for the homeless and hungry.

Day, Stephen Stephen Day (or Daye), b. *c.*1594, d. Dec. 22, 1668, set up the first printing plant in British

America. A locksmith in Cambridge, England, he contracted in 1638 to establish a press in New England for the Rev. Jesse Glover, who shared the Puritan interest in promoting an informed understanding of the Bible. Although his employer died, Day used the equipment Glover had imported to set up a printing shop in Cambridge, Mass. He managed the plant until 1649, and 22 imprints were issued during his tenure. The first was a broadside, *The Freeman's Oath* (1639); the best known, now called the BAY PSALM BOOK (1640), was the first book printed in British North America.

Day, Thomas An English writer and social reformer, Thomas Day, b. June 22, 1748, d. Sept. 28, 1789, was the author of *The History of Sandford and Merton* (3 vols., 1783–89), a moralizing children's book that illustrates the ideas of the French philosopher Rousseau. Day was a supporter of the American Revolution, and his poem "The Dying Negro" (1773) helped to inspire the English antislavery movement.

day-care center A day-care center is a place where children are cared for when their parents are away from home or are for some other reason unable to give the children the care needed. With the exception of centers for poor children, opened during the Depression of the 1930s, and centers for use by working mothers during World War II, the level of publicly funded day care in the United States remained very low until the federal HEAD START program opened nursery schools in the mid-1960s. Most publicly funded U.S. day-care facilities are limited to low-income groups, but because more than 55 percent of mothers of preschool-age children are now in the work force and as the need for programs has become more acute, child care has become a political and economic issue for many. Currently, most U.S. day-care centers are private and operate from homes, churches, such centers as the YWCA, schools, and other facilities. Some U.S. companies also maintain on-site day-care centers for their employees.

Most contemporary U.S. day-care programs focus on children between the ages of three and six and have programs similar to those of nursery schools, with an emphasis on preparing children socially and intellectually to enter school (see PRESCHOOL EDUCATION). Programs may be offered for a full day or a half day, and the concentration is on play with other children, supervised by a trained adult. Day care for school-age children is usually limited to supervised recreation during the hours between the end of the school day and the end of the parents' workday.

Day-Lewis, C. Cecil Day-Lewis, b. Apr. 27, 1904, d. May 22, 1972, became England's poet laureate in 1968 after an active career as poet, translator of Valéry and Vergil, university professor, and writer (under the pseudonym Nicholas Blake) of detective fiction.

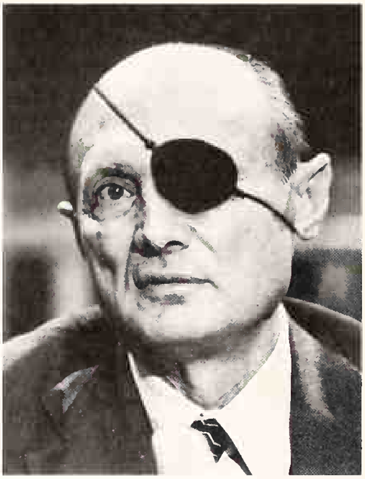
Profoundly affected by World War I and its aftermath, both at Oxford and during the 1930s Day-Lewis was associated with poets—at first with the Georgians, and then with a group that included W. H. Auden, Louis MacNeice, and Stephen Spender—who believed that the social order built by the Victorians and Edwardians had died with the war and must be replaced. This was a view he championed in such early volumes of literary criticism as *A Hope for Poetry* (1934) and *Revolution in Writing* (1935). His own poetry includes *Collected Poems, 1929–1933* (1935) and the less didactic *Collected Poems* (1954), *Pegasus* (1957), and *The Whispering Roots* (1970).

Day-Lewis also achieved popularity as the author of such sophisticated mysteries as *A Tangled Web* (1956) and *The Worm of Death* (1961). His autobiography, *The Buried Day*, appeared in 1960.

day lily Day lily is the common name for about 15 to 20 species of flowering perennial plants making up the genus *Hemerocallis,* in the lily family, Liliaceae. They are native from central Europe to Japan. The hardy plants, which have fibrous or bulbous roots and grasslike leaves, can endure sharp climate changes. Some day lilies grow up to 2 m (7 ft) high.

The flowers of the day lily plant (left) *bloom for only one day. Varieties include lemon and orange day lilies, as well as hybrid color combinations.*

Dayan, Moshe [dah-yahn', moh'-she] Moshe Dayan, b. Degania, Palestine, May 20, 1915, d. Oct. 16, 1981, was a leading Israeli general and statesman. A major commander in the first Arab-Israeli War (1948), he became chief of the Israeli General Staff in 1953 and directed Israel's invasion of Sinai during the 1956 war. Elected to the Knesset in 1959, Dayan served in successive Labor governments as minister of agriculture (1959–64) and of defense (1964–74); he won new plaudits for Israel's lightning victory in the 1967 war but was blamed for failure to anticipate the Arab attack in 1973. As for-



Moshe Dayan, who lost an eye while fighting with Allied forces in Lebanon during World War II, played a notable role, either as a commander or as defense minister, in four Arab-Israeli Wars. Dayan served as foreign minister in Menachem Begin's government from 1977 to 1979.

eign minister (1977–79) in Menachem Begin's government, Dayan played a key role in negotiation of the 1979 Israeli-Egyptian treaty.

daydream A daydream is a fantasy activity (see FANTASY, psychology) that is a normal part of waking life. It usually occupies a total of a few minutes a day in the life of the average adult, and a single daydream may last only a few seconds. Such fantasies most often deal with everyday problems, but they may also be wish-fulfilling or sexual in nature. In childhood, daydreams are commonly more numerous and less confined in subject matter. Some fantasy-prone adults, however, continue to have long, elaborate daydreams.

Daydreaming is a form of response to periods when full mental attention is not engaged, and it is allied to the creative functions of the unconscious mind. It is considered to become a psychological problem only infrequently, in those instances when a person loses conscious control of such activity and has difficulty distinguishing fantasy from reality.

dayglow see AIRGLOW

Daylight Saving Time Daylight Saving Time (DST) provides more usable hours of daylight for human activities by setting clocks ahead one hour in the spring. Although the total amount of daylight remains the same, more daylight hours are allowed for outdoor work and recreation in the late afternoon and evening. Daylight Saving Time can also reduce power requirements for lighting. In most parts of the United States, year-round Daylight Saving Time was adopted during World War II. Now it is in effect only during that part of the year when daylight hours are the longest. Congress fixed this period as extending, as of 1987, from the first (previously the last) Sunday in April to the last Sunday in October.

Dayton A city in southwestern Ohio, located on the Great Miami River, where it is joined by the Stillwater and Mad rivers, Dayton is the seat of Montgomery County. The city has a population of 182,044 (1990), and 951,270 persons live in the metropolitan area. The city is a center of heavy industry and aviation research and is a port of entry.

Dayton was settled in 1796. It grew with the opening (1829) of the first section of the Miami and Erie Canal and the arrival of the railroads in the 1850s. During the Civil War the city's industries boomed. Dayton became known as the "birthplace of aviation" after Orville and Wilbur Wright's experiments there led to the flight near Kitty Hawk, N.C., in 1903. Dayton was the first U.S. city to adopt (1913) the city-manager type of government. As the result of a series of floods in the late 19th and early 20th centuries, a flood-control system for the Miami River valley was established.

Daytona Beach Daytona Beach (1990 pop., 61,921) is a resort city in northeastern Florida, located on the Halifax River, a lagoon of the Atlantic Ocean. The economy is based on tourism, boatbuilding, fruit processing, and aerospace industries. The beach, of hard white sand, is about 40 km (25 mi) long and 150 m (500 ft) wide at low tide. Internationally famous auto races are held there each February. The city was founded in 1870.

Dazai Osamu [dah'-zy oh-sah'-moo] Dazai Osamu, b. June 19, 1909, d. June 13, 1948, was a Japanese novelist who poignantly captured the mood of despair in postwar Japan. He wrote many short stories, but his reputation rests mainly on two novels he wrote after World War II, *The Setting Sun* (1947; Eng. trans., 1956) and *No Longer Human* (1948; Eng. trans., 1958). His writings are representative of an important genre of modern Japanese literature—autobiographical fiction in which personal experience dictates, and sometimes overwhelms, the artist's public career. In Dazai's case the dissipations of private life finally consumed his art. After years of alcoholism and drug addiction and several suicide attempts—all recorded faithfully in his novels—he drowned himself in a river outside Tokyo. What saves his writing from self-pity are the flashes of humor and the sometimes savage insights into the decadent society he knew so well.

DC (direct current) see CIRCUIT, ELECTRIC

DC-3 The Douglas DC-3 is a transport plane that was designed for service with U.S. domestic airlines. With a span of about 29 m (95 ft), the low-wing monoplane was powered by two 1,200-horsepower Pratt & Whitney R-1830-92 radial engines. During World War II, a military version, the Douglas C-47 Skytrain, was constructed for use with the U.S. Army Air Forces (USAAF). In addition to

The famous DC-3 was a reliable twin-engine transport plane capable of carrying 21 passengers at 309 km/h (192 mph). It was flown by the world's major airlines for more than a decade after its maiden flight in 1935.

its duties as a troop and supply transport, the C-47 was used to carry paratroopers and tow gliders. Production of the commercial DC-3 continued until 1946, and in the 1990s some DC-3s were still being modified for use as turboprops.

See also: AVIATION.

DDT The widely used insecticide DDT is a colorless, crystalline chemical, formula $C_{14}H_9Cl_5$. Its name is derived from its generic name, *d*ichloro*d*iphenyl*t*richloroethane. DDT is insoluble in water, moderately soluble in alcohols and aliphatic hydrocarbons, and highly soluble in many aromatic and chlorinated solvents. It is a very active, broad-spectrum pesticide (see PESTICIDES AND PEST CONTROL), particularly effective against beetles, moths and butterflies, flies, and mosquitoes.

First isolated in 1874 by Othmar Zeidler in Germany, DDT was unrecognized as a potent insecticide until rediscovered by Paul Müller of Switzerland in 1939. Müller received the Nobel Prize for medicine for his discovery of its effectiveness in controlling insect-vectored human diseases. It was heavily used in World War II. Incipient epidemics of typhus and malaria were reduced by the postwar use of DDT.

Subsequently, many countries in Asia, Africa, and South and Central America, where MALARIA had been endemic for centuries, were cleansed of the anopheline mosquito vector by DDT spraying.

The application of DDT to cultivated crop plants and to livestock substantially increased yields. In 1962, however, the publication of biologist Rachel Carson's SILENT SPRING raised fears that DDT was causing a dramatic decrease in the numbers of many species of birds because it disrupts avian reproductive processes and causes the laying of infertile or deformed eggs. Due to its extremely slow breakdown in the soil, DDT buildup in the food chain also caused concern.

No conclusive evidence of DDT's pathological effects on humans has yet come to light, but links have been determined in laboratory studies of rats and mice. As a result of such studies and environmental concerns, however, the use of DDT was banned in the United States in 1972. It remains in wide use elsewhere in the world.

de Broglie, Louis [duh broy] The French physicist Louis de Broglie, b. Aug. 15, 1892, d. Mar. 19, 1987, is known for his theory that matter has the properties of both particles and waves. This particle-wave duality, derived from the work of Albert Einstein and Max Planck, was experimentally confirmed, for the electron, in 1927. De Broglie received the 1929 Nobel Prize for physics. His theory that a wavelength is associated with every moving object is one of the keystones of the "new" QUANTUM MECHANICS.

de Chirico, Giorgio see CHIRICO, GIORGIO DE

de Falla, Manuel see FALLA, MANUEL DE

De Filippo, Eduardo [day fee-lip'-poh, ay-dwar'-doh] Eduardo De Filippo, b. May 24, 1900, d. Nov. 1, 1984, was a member of a well-known Neapolitan theater family and one of Italy's foremost playwrights, actors, and directors. Deeply influenced by Pirandello, his more than a dozen plays, many written in the Neapolitan dialect, emphasize human joys and sufferings and the clash between reality and illusion. *Napoli Milionaria!* (1945; film, 1950), one of his finest works, is a compassionate portrait of the moral confusion and frenzy of postwar Italy. *Filumena Marturano* (1946) was made into the popular film *Matrimonio all'italiana* (*Marriage Italian Style*, 1964).

De Forest, Lee Lee De Forest, b. Council Bluffs, Iowa, Aug. 26, 1873, d. June 30, 1961, was a pioneer of wireless telegraphy in the United States. A prolific inventor, he was granted more than 300 patents in the fields of wireless telegraphy, radio, wire telephone, sound-on-film, picture transmission, and television. He is most widely known for introducing a third electrode into the DIODE, a two-electrode ELECTRON TUBE, creating the TRIODE, or Audion tube, which could amplify radio signals and generate oscillations; these two functions had many important applications.

de Gasperi, Alcide [day gah'-spay-ree, ahl-chee'-day] Alcide de Gasperi, b. Apr. 3, 1881, d. Aug. 19, 1954, was an outstanding Italian Christian Democratic statesman. In 1919 he helped Luigi Sturzo found the Catholic Popular party. Arrested by the Mussolini regime in 1927, he was released 16 months later through Vatican intercession.

In 1942–43, de Gasperi secretly reorganized the Popular party into the Christian Democratic party. In December 1945, after the liberation of Italy, he formed the first of eight centrist governments he was to head until August 1953. An advocate of European integration, he led Italy into the Marshall Plan, the North Atlantic Treaty Organization (NATO), and the European Community.

de Gaulle, Charles Charles de Gaulle, b. Nov. 22, 1890, d. Nov. 9, 1970, the symbol of French resistance during World War II, was president of the provisional government (1944–46) and the founding president of the Fifth Republic from 1958 to 1969.

Early Life. Charles André Marie Joseph de Gaulle was born in Lille to bourgeois, patriotic, and devoutly Catholic parents. A lieutenant in World War I, he was wounded several times and captured at Verdun by the Germans. After the war, de Gaulle studied and lectured at the École Supérieure de Guerre (War College) and so impressed that the eminent Marshal Henri PÉTAIN appointed him to the secretariat of the Supreme War Council and later the National Defense Council.

In the 1930s, de Gaulle alienated the military establishment by criticizing, in his book *The Army of the Future* (1934; Eng. trans., 1940), the overreliance on the MAGINOT LINE and by advocating formation of an elite corps of armored divisions similar to the German panzer divisions. These ideas were not accepted either in military circles or in parliament.

World War II. Fame came to de Gaulle with World War II. Amid the myriad setbacks suffered by French military forces during the May 1940 German invasion, de Gaulle conducted one of the few successful tank operations against the enemy. Paul Reynaud, then premier, appointed the newly promoted General de Gaulle undersecretary of war on June 5. Reynaud's resignation and the apparent intention of his successor, Pétain, to surrender, led de Gaulle to flee to London and issue a radio appeal on June 18 for the French nation to resist.

De Gaulle's defiance earned him a death sentence *in absentia* from a military court of the new VICHY GOVERNMENT, but he persisted in building up Free French and resistance forces and ultimately secured support from Allied leaders. In 1943, de Gaulle formed a provisional French government, which reentered France after the Allied Normandy invasion of June 1944.

As president of the provisional government from 1944 to 1946, de Gaulle worked with the Allies to complete the Nazi defeat and with the Constituent Assembly to govern France and draw up a constitution for the Fourth Republic. However, he opposed the constitutional draft because of its failure to give significant power to the executive branch. For this and other reasons he resigned in January 1946. From then until 1958, de Gaulle was in retirement, writing his memoirs and also campaigning for a few years for a political grouping labeled the *Rassemblement du Peuple français* (RPF).

Presidency. In 1958, when the Algerian War threatened civil war in France, de Gaulle was asked to form a government. Assuming the premiership on June 1, he was given temporary emergency powers and the right to draft a new constitution. This constitution, which vested the president with strong executive powers, was approved by popular referendum in September 1958, and de Gaulle was elected president of the Fifth Republic by an overwhelming majority in December.

Charles de Gaulle, the World War II leader of the Free French forces, was summoned from retirement in 1958 to form a government capable of dealing with the crisis fomented by the Algerian War. Under his leadership, an Algerian settlement was reached and France reasserted itself in international affairs.

De Gaulle's first task as president was to settle the Algerian question. He used his emergency powers to surmount the crisis, and an independent Algerian state was finally established in 1962. Having restored confidence in the government and relieved the drain of the colonial war in Algeria, de Gaulle and his government built upon the foundations laid by the Fourth Republic to modernize and expand the economy and to achieve currency stabilization, favorable trade balances, full employment, and general prosperity. In foreign policy de Gaulle asserted French influence in the European Common Market and vetoed British entry in 1967; loosened ties with the United States and NATO; established French nuclear power in the civilian and military realms; opened relations with Communist China; and built new ties with the Third World.

De Gaulle's repudiation by the electorate and resignation in 1969 stemmed from the student-worker revolt of May–June 1968. De Gaulle's disdain for such a display led him and his government to a vigorous policy of detaching worker support from the student movement and isolating the latter. His success was short-lived, however, and in an April 1969 referendum on relatively minor issues, the voters cast a strong majority of "no" ballots. De Gaulle resigned on April 28, leaving the reins of the republic to his follower Georges POMPIDOU. De Gaulle then retired to Colombey-les-Deux-Églises, where he died the following year.

De Havilland, Olivia Olivia De Havilland, b. July 1, 1916, like her sister, Joan Fontaine, was a British-born Hollywood star. She debuted in *A Midsummer Night's Dream* (1935) and played demure heroines, as in *Gone with the Wind* (1939), until she emerged, ten years later, as a leading actress in *The Dark Mirror* (1946), *To Each His Own* (1946; Academy Award), *The Snake Pit* (1949), and *The Heiress* (1949; Academy Award).

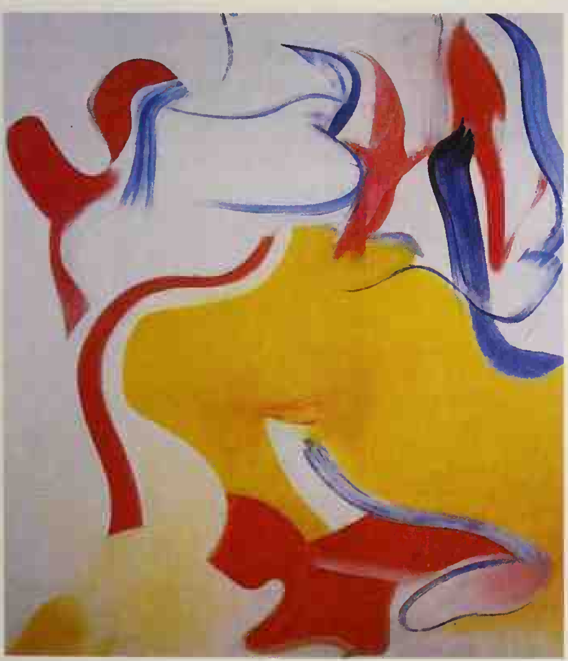
De Kalb, Johann see KALB, JOHANN

de Klerk, F. W. Frederik Willem de Klerk, b. Mar. 18, 1936, became leader of the NATIONAL PARTY in February 1989 and president of South Africa in August 1989. De Klerk was elected to parliament in 1972, became party leader in Transvaal in 1982, and held several cabinet posts before being named party chief and then acting president after P. W. BOTHA resigned. In 1990, after his party won the September 1989 elections, he ended the ban on the AFRICAN NATIONAL CONGRESS, released black leader Nelson MANDELA, pledged to end APARTHEID, and began negotiations to give blacks a national political role. In 1991 he moved to repeal apartheid legislation.

de Kooning, Willem Willem de Kooning, b. Rotterdam, Holland, Apr. 24, 1904, is one of America's foremost painters in ABSTRACT EXPRESSIONISM. He studied (1916–24) at the Rotterdam Academy of Fine Arts and Techniques and in 1926 moved to the United States. His style became increasingly abstract, especially after he became acquainted with Arshile GORKY in 1929. During the late 1930s and early 1940s, de Kooning painted both figurative and nonfigurative subjects, which led to a series of abstract paintings of women produced from the mid-1940s to the mid-1950s. These figures are monumental and expressive, evoking both goddesses and ancient rites and contemporary woman.

De Kooning tries to capture his transient thoughts and feelings as he paints. The spectator interprets de Kooning's images as they reflect the viewer's own feelings and experiences. In 1963 de Kooning moved from New York City to rural Long Island, N.Y., where he began painting landscapes, including some with figures. These works have a lushness and playfulness somewhat suggestive of the late works of Peter Paul Rubens. De Kooning taught at Black Mountain College (N.C.; 1948) and at Yale University (1950–51).

The special character of Willem de Kooning's recent work resides in his application of thin color bands. In Untitled V *(1983) de Kooning used a simple scheme of complementary colors, turbulently dispersed among empty spaces.*



de la Madrid Hurtado, Miguel Miguel de la Madrid Hurtado, b. Dec. 12, 1934, succeeded José López Portillo as president of Mexico in December 1982. De la Madrid served as Mexico's deputy finance minister from 1975 to 1979 and was minister of planning and budget from 1979 to 1981. As president, he continued the financial austerity measures needed because of falling oil revenues. He was succeeded by Carlos SALINAS DE GORTARI in 1988.

de la Mare, Walter Walter John de la Mare, b. Charlton, Kent, England, Apr. 25, 1873, d. June 22, 1956, was a poet, short-story writer, novelist, and anthologist. One of his best-known poems is the title work of *The Listeners and Other Poems* (1912). Later volumes, such as *Collected Poems* (1941) and *Inward Companion* (1950), further reflect his quest for "the all-but-uttered, and yet out of reach." A number of his short stories are masterly exercises in fantasy or horror. De la Mare's novels include *Memoirs of a Midget* (1921), a strange work that probes into a passionate and troubled being. Among his anthologies for children and adults is *Come Hither* (1923).

De la Ramée, Louise see OUIDA

de la Roche, Mazo [duh-lah-rohsh', may'-zoh] A Canadian author of novels, plays, and children's stories, Mazo de la Roche, b. Newmarket, Ontario, Jan. 15, 1879, d. July 12, 1961, is best known as the creator of the Whiteoaks family of Jalna. This famous clan first appeared in *Jalna,* which won her the $10,000 *Atlantic Monthly* competition for the best novel of 1927. In 15 sequels published between 1929 and 1960, de la Roche continued the history of the family of Philip Whiteoak, an English army officer who, in the mid-19th century, settled at Jalna, on Lake Ontario near Toronto.

De La Warr, Thomas West, 12th Baron Lord De La Warr, b. July 9, 1577, d. June 7, 1618, was the first governor of colonial Virginia. He arrived there in 1610 to find JAMESTOWN on the verge of extinction as a result of the harsh winter—the "starving time" of 1610–11. He revived the settlement before returning (1611) to England. The Delaware River and state take their names from him.

De Lancey (family) The De Lanceys were a wealthy and influential family in colonial New York. **James De Lancey**, b. Nov. 27, 1703, d. July 30, 1760, was chief justice of New York's supreme court (1733–60) and lieutenant governor of the colony (1753–60). He was one of the presiding justices at the libel trial (1735) of John Peter Zenger and a vigorous opponent of Gov. George Clinton (see Clinton family).

His son, **James De Lancey II**, 1732–1800, succeeded him as leader of the aristocratic De Lancey faction and controlled the New York Assembly from 1769 to 1775. He moved to England at the outbreak of the American Revolution. Other family members fought as Loyalists in the Revolutionary War. Most notable was **Oliver De Lancey**, b. Sept. 16, 1718, d. Oct. 27, 1785.

De Leon, Daniel Daniel De Leon, b. Curaçao, Dec. 14, 1852, d. May 11, 1914, was a militant American Marxist. After teaching at Columbia University (1883–89), he joined the Socialist Labor party in 1890. In 1895, De Leon founded the Socialist Trade and Labor Alliance, which declined after the withdrawal of members opposed to his doctrinaire Marxism. He helped found the Industrial Workers of the World in 1905 but was expelled in 1908. He continued speaking and writing for the Socialist Labor party until his death.

De Long, George Washington George Washington De Long, b. New York City, Aug. 22, 1844, d. Oct. 30?, 1881, was an American Arctic explorer, whose expedition of 1879–81 proved the existence of a northwestern polar current and determined that Wrangel Island was not a large landmass. On this expedition De Long's ship, the *Jeannette,* was trapped in the ice north of Siberia and drifted about 485 km (300 mi) in 21 months. It was crushed by the ice on June 12, 1881, and De Long and his party headed south to Siberia, which they reached in September 1881. De Long discovered the tiny De Long islands that were later named for him.

De Los Angeles, Victoria [day-lohs-ahn'-hay-lays] Victoria De Los Angeles, b. Nov. 1, 1923, is a Spanish soprano admired for both her operatic performances and her recitals. She made her operatic debut in Madrid in 1946 as the countess in Mozart's *The Marriage of Figaro.* She appeared at the Metropolitan Opera for 12 consecutive seasons beginning in 1950.

de Mille, Agnes Choreographer and dancer Agnes de Mille, b. New York City, Sept. 15, 1905, achieved fame as the creator of a popular theatrical dance form, the dance story, which mixes folk-based choreography with the technical requirements of ballet. After studying with a diverse array of teachers, including Theodore Kosloff in California and, later, Dame Marie Rambert in London, she achieved a modest renown as a solo dancer. In 1940 she choreographed *Black Ritual* and in 1941 *Three Virgins and a Devil,* both for the young Ballet Theatre, now the American Ballet Theatre (ABT); her *Fall River Legend* (1948), which is still ranked as her finest work, remains in ABT's repertoire. De Mille achieved success in 1942 with *Rodeo* for the Ballet Russe de Monte Carlo. *Rodeo,* a narrative comic ballet on American themes that allied elements of folk, social, and modern dance with a canny sense of theater, is currently in the repertoire of the Joffrey Ballet.

Even greater success followed for de Mille with her choreography for *Oklahoma!* (1943) by Richard Rodgers and Oscar Hammerstein II, which introduced a vogue for extended dance sequences in Broadway musicals and made her a household name. Later hits included *Bloomer Girl* (1944), *Carousel* (1945), *Brigadoon* (1947), *Gentlemen Prefer Blondes* (1949), and *Paint Your Wagon* (1951). Although she continued to choreograph in later years, de Mille increasingly turned her attention to the preservation of American folk dance. In 1973 she founded the Heritage Dance Theater at the North Carolina School of the Arts.

De Mille, Cecil B. Cecil Blount De Mille, b. Ashfield, Mass., Aug. 12, 1881, d. Jan. 21, 1959, was a major American film director best known for his spectacular productions. De Mille began his career as an actor and made his first directorial mark in classic silent Westerns such as *The Squaw Man* (1913), the first feature film made in Hollywood, and *The Virginian* (1914). With Samuel Goldwyn and Jesse Lasky, he formed (1912) a studio that, after its merger in 1918 with Adolph Zukor's studio, became Paramount Pictures. De Mille is particu-

Cecil B. De Mille, an American film producer and director, was acclaimed as the "father of the Hollywood spectacular." De Mille achieved success at the box office, as well as enduring fame among moviegoers, with such lavish productions as The Ten Commandments.

larly noted for his lavish biblical epics, *The Ten Commandments* (1923 and 1956), *The King of Kings* (1927), and *Samson and Delilah* (1949). Among De Mille's 70 films, other notable productions are *Cleopatra* (1934); *The Plainsman* (1938) and *Union Pacific* (1939), both Westerns; and *The Greatest Show on Earth,* which won the 1952 Academy Award for best picture.

De Niro, Robert [duh-neer'-oh] Robert De Niro, b. New York City, Aug. 17, 1943, is an American actor known especially for his work in the films of director Martin SCORSESE. These include *Mean Streets* (1973); *Taxi Driver* (1976); the musical *New York, New York* (1977); *Raging Bull* (1980), for which De Niro won an Academy Award; and *The King of Comedy* (1982). Among his other films are *The Godfather, Part II* (1974), *1900* (1977), *The Deer Hunter* (1978), *Once Upon a Time in America* (1984), *Midnight Run* (1988), *Jacknife* (1989), and *Awakenings* (1990).

de Nobili, Roberto [day-noh'-bee-lee] Roberto de Nobili, b. September 1577, d. Jan. 16, 1656, was an Italian Jesuit missionary who adopted native customs in his attempt to convert India. The first European to become familiar with Indian literature, de Nobili wrote many religious works in Sanskrit, Tamil, and Telugu. His converts to Christianity numbered about 100,000.

De Quincey, Thomas The English essayist Thomas De Quincey, b. Aug. 15, 1785, d. Dec. 8, 1859, is recognized as a master of prose style. He is best known for his autobiographical *Confessions of an English Opium-Eater,* which was first printed in two parts in the *London Magazine* in 1821. Although he initially intended the work to be a journal of his drug addiction, De Quincey later regarded it as an exploration of the nature of dreams.

Thomas De Quincey, an English essayist of the early 19th century, achieved renown for his imaginative and fluent Confessions of an English Opium Eater *(1821), an account of his drug-induced visions. An early admirer and friend of Wordsworth and Coleridge, De Quincey wrote literary criticism as well as autobiographical reflections.*

The son of a merchant, De Quincey ran away from Manchester Grammar School at age 17, wandered through Wales, and lived a beggar's life in London. Already in ill health, he was rescued by his family and enrolled in Worcester College, Oxford, which he left halfway through exams. At Oxford, he began taking opium, probably to relieve a chronic facial pain, and gradually became addicted. Through his friend Samuel Coleridge, De Quincey met (1808) William Wordsworth, whose house (Dove Cottage) in the Lake District he leased for many years. His writings include autobiography (notably the *Confessions* and an uncompleted sequel, *Suspiria de Profundis,* 1845–49), biography (especially of his contemporaries Wordsworth, Coleridge, and Southey), fiction (including a Gothic novel, *Klosterheim,* 1832), history, literary criticism (such as the well-known essay "On the Knocking at the Gate in *Macbeth,*" 1823), and economic theory (including *The Logic of Political Economy,* 1844).

De re metallica see AGRICOLA, GEORGIUS

De rerum natura see LUCRETIUS

De Sica, Vittorio [day see'-kah] The Italian film director and actor Vittorio De Sica, b. July 7, 1901, d. Nov. 13, 1974, achieved international recognition after World War II for his important contributions to Italian neorealistic cinema as well as for his numerous, mostly comic, starring roles. De Sica directed his first film, *Rose Scarlette,* in 1940. *The Children Are Watching Us* (1942) marked the beginning of his long collaboration with the screenwriter and theorist of neorealism Cesare Zavattini. Fame came with *Shoeshine* (1946), a harsh social commentary on war-ravaged Italy that exemplified the neorealist style. This was followed by *Bicycle Thieves* (1948), *Miracle in Milan* (1951), and *Umberto D* (1952).

During the 1950s, De Sica appeared in more than 50 films, playing his most memorable role as the scoundrel-turned-hero of *General della Rovere* (1959). In the 1960s two of his films—*Two Women* (1960) and *Yesterday, Today, and Tomorrow* (1963)—won Academy Awards. With *The Garden of the Finzi-Continis* (1971), about the plight of Jews in Fascist Italy, De Sica returned to social commentary. His last picture was *A Brief Vacation* (1973).

De Smet, Pierre Jean [dee-smet'] Pierre Jean De Smet, b. Dendermonde, Belgium, Jan. 30, 1801, d. May 23, 1873, was a pioneering Jesuit missionary among the Indians of North America. After founding (1838) a mission among the Potawatomi Indians at Council Bluffs, Iowa, he established Saint Mary's mission near the present-day site of Missoula, Mont., in 1841; three years later, on the Willamette River in Oregon, he opened the most important in a chain of missions covering the Northwest. De Smet traveled extensively among scores of tribes, often in a peacemaking capacity. Through his courage and powerful personality, he earned the respect of Northwestern and Plains tribes.

Hernando de Soto was probably the first European to sight and cross the Mississippi inland, reaching the river in 1541. A ruthless conquistador who had fought in Central America and Peru, de Soto brutalized American Indians from Florida to Oklahoma in a fruitless search for gold and jewels.

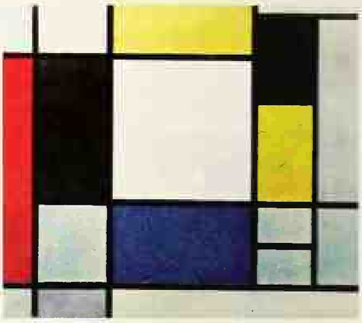
de Soto, Hernando Hernando de Soto, b. *c.*1500, d. May 21, 1542, is the Spanish explorer in America credited with discovery of the Mississippi River. De Soto served in Central America and joined the expeditions of Diego de Almagro and Francisco Pizarro that conquered the Incas of Peru. In 1537 he was named governor of Cuba and given permission to conquer Florida.

Sailing from Spain in 1538, de Soto landed on the Florida coast south of Tampa Bay on May 30, 1539. He advanced northward through the present states of Florida, Georgia, and the Carolinas, following the ruthless practice of capturing the chief of a village, holding him for ransom, and plundering the town of food and women. After wintering in Florida, de Soto's force marched through Georgia and Tennessee into Alabama. After a bloody battle with the Indians at Maubilla in October, the greatly depleted force made its way into Mississippi, where it spent the winter of 1540–41.

In May 1541, de Soto's expedition reached the Mississippi River, which it crossed, either in the vicinity of Memphis or at Sunflower Landing. De Soto and his men were perhaps the first Europeans to see that river inland. The expedition continued into Arkansas and made its winter camp, perhaps in the vicinity of Fort Smith, near the present Arkansas-Oklahoma border. It then returned to the Mississippi, where de Soto died and was buried in its waters.

de Stijl [duh styl] The influential Dutch magazine *de Stijl* was founded in May 1917 and first published the following October, with the painter, architect, and poet Theo Van Doesburg as editor. Eighty-seven editions were published before Van Doesburg's death in 1931, and their impact on the development of modern art was considerable. The ideas associated with the magazine, as expressed in its first manifesto published in November 1918, are also referred to as *de Stijl,* which means simply "the style."

Regular contributors to the magazine were the architect J. J. P. Oud; the designer Gerrit Rietveld, whose famous *Red and Blue Chair* epitomizes *de Stijl* thinking; and, most important, the painter Piet Mondrian, who utterly rejected the idea that the source of inspiration was still to be found in nature. Based on the mathematical philosophy of M. J. H. Schoenemaekers, the *de Stijl* concept of neoplasticism (a plastic idiom equally applicable to painting, architecture, and the decorative arts) influenced both the constructivists (see constructivism) and the Weimar Bauhaus.



Composition with Red, Yellow and Blue *(1920) is by the Dutch artist Piet Mondrian (1872–1944), the most prominent painter associated with the movement known as* de Stijl. *(Private collection, Amsterdam.)*

de Valera, Eamon [deh-vuh-lair'-uh, ay'-muhn] Eamon de Valera, b. Oct. 14, 1882, d. Aug. 29, 1975, was the leading Irish statesman of the 20th century. He was born in New York City, but after the death of his Spanish father he was sent to live with his mother's relatives in Ireland. He joined the Irish Volunteers in 1913, took part in the abortive Easter Rising of 1916, and was the most senior officer to escape execution after his surrender.

Released from internment in 1917, de Valera was elected president of Sinn Fein, and in 1919 he became president of Dáil Éireann, the revolutionary assembly. His opposition to the 1921 negotiations with Britain left the leadership to Arthur Griffith and Michael Collins, who defended a treaty offering Ireland less than full independence. De Valera and his antitreaty forces were defeated in the ensuing civil war.

Eamon de Valera was a leading figure in the struggle for Irish independence. Although he repudiated the treaty that established the Irish Free State in 1922, de Valera later became prime minister and asserted full sovereignty for Ireland in 1937. From 1959 to 1973 he was president of the republic.

In 1927, de Valera took the oath of allegiance required to sit in the Dáil of the Irish Free State. Thereafter, his FIANNA FÁIL quickly became the largest party in Irish politics and de Valera was prime minister three times (1932–48, 1951–54, and 1957–59). The 1937 constitution, which he drafted, broke nearly all links with the British crown, claimed jurisdiction over Northern Ireland, and recognized the special position of the Roman Catholic church in Ireland. Such policies, and the decision to remain neutral in World War II, hardened the resistance of Northern Irish Protestants to Irish unification. In his inability to comprehend Protestant Ulster's fears of Catholic domination, de Valera was representative of his generation in southern Ireland. He died after serving two terms (1959–73) in the ceremonial office of president.

De Voto, Bernard Bernard Augustine De Voto, b. Ogden, Utah, Jan. 11, 1897, d. Nov. 13, 1955, was an editor, literary critic, and historian of the American West. After teaching at Northwestern and Harvard, De Voto was editor of the *Saturday Review of Literature* from 1936 to 1938. He was also an editor of *Harper's*, for which he wrote an important column, "The Easy Chair" (1935–55). His first book, *Mark Twain's America* (1932), was a convincing polemic against Van Wyck Brooks's position that Twain was a deeply flawed writer. He later edited Twain's unpublished papers and also published an edition of *The Journals of Lewis and Clark* (1953). De Voto wrote several histories of the frontier, including *The Year of Decision: 1846* (1943), the Pulitzer Prize–winning *Across the Wide Missouri* (1947), and *The Course of Empire* (1952).

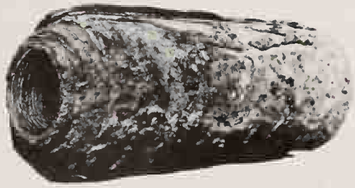
de Witt, Johan see WITT, JOHAN DE

Dead Sea The Dead Sea—also called Buhayrat Lut (Arabic: "Sea of Lot") and Yam ha-Melah (Hebrew: "Salt Sea")—is a salt lake located on the border between Israel and Jordan. Its shoreline is the lowest point on the Earth's surface, averaging 396 m (1,300 ft) below sea level. The lake is 1,049 km^2 (405 mi^2) in area, 74 km (46 mi) long, and about 16 km (10 mi) wide. Its depth ranges from a maximum of 399 m (1,310 ft) in the north to less than 3 m (9 ft) in the south. Some of the water from its major tributary, the JORDAN RIVER, has been diverted for irrigation, reducing the flow into the lake and lowering its level. A tongue of land now cuts off the southern quarter of the lake, which is fed water through an artificial channel and consists almost entirely of evaporation ponds.

The lake occupies the lowest trench in the GREAT RIFT VALLEY. Flanked on east and west by parallel anticlinal ridges of sandstone and dolomite, it has no outlet, but evaporates at the rate of about 1,400 mm (55 in) annually. The Dead Sea is about seven times as salty (nearly 30% by volume) as the ocean; its density keeps swimmers afloat. Only simple organisms can live in its saline waters. The area is hot and dry, with annual rainfall of only about 50 mm (2 in).

The lake features prominently in Jewish history. It is associated with Abraham, Lot, David, Solomon, and the defenders of Masada. The first Dead Sea Scrolls were found at Qumran on the northeastern shore.

Dead Sea Scrolls The Dead Sea Scrolls are Hebrew, Aramaic, and Greek manuscripts discovered (1947–56) in caves near Wadi QUMRAN, in what is now the Israeli-occupied West Bank, on the northwestern shore of the Dead Sea. They were left there by a Jewish community that lived in the area about 2,000 years ago. The scrolls contain several types of Jewish religious literature, including many parts of the Old Testament in Hebrew, Greek translation, and Aramaic paraphrase (Targum). Biblical material was also rewritten, imitated, and expanded in stories, thematic collections of biblical texts, commentaries, hymns, psalms, blessings, prayers, exhortations to wisdom, and elaborations of biblical law. Also found were nonbiblical Jewish literature and scrolls that testify to the worldview and theology of the Qumran community. Among the latter are the Community Rule, which defines its goals and way of life; the War Scroll, which describes the final, apocalyptic battle of good against evil; and the Temple Scroll (which some date prior to the community), describing an ideal Jerusalem Temple and laws for a sanctified people. The collection consists chiefly of thousands of fragments, most of them very



(Above) *This scroll, containing complete copies of 45 Hebrew psalms, dates from the 1st century* AD *and is among the best preserved of the manuscripts discovered north of the Dead Sea.* (Below) *The Dead Sea Scrolls include the earliest manuscripts of the Old Testament, or Hebrew Bible. This Isaiah Scroll, containing part of the Book of Isaiah, is one of the best preserved.*

small. Complete documents are relatively few in number.

Although they had been preserved in dry caves for almost 2,000 years, all the scrolls show some damage—frayed edges, deterioration, and discoloration. Many of the texts still have not been published.

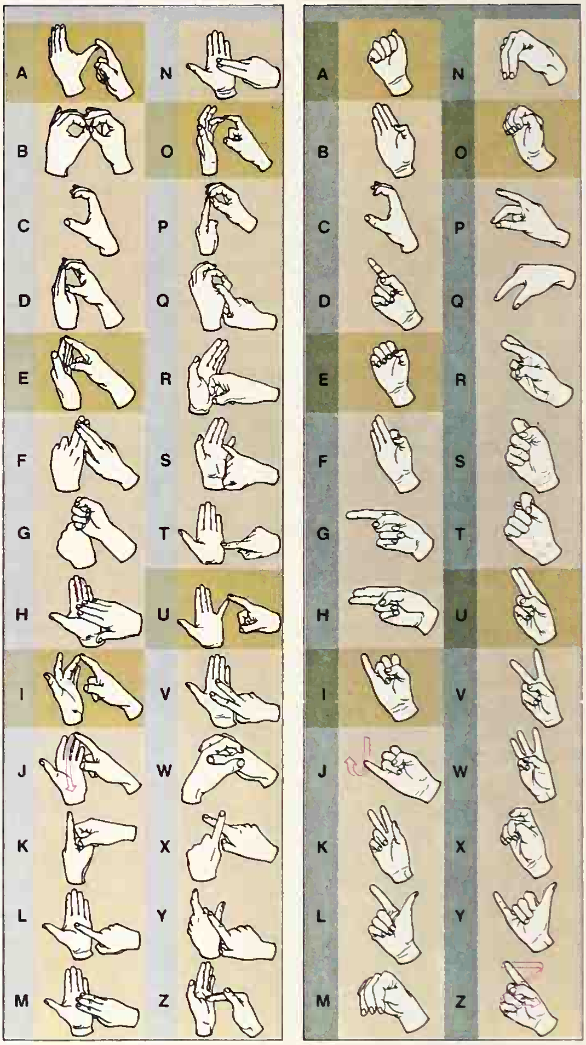
The original publication of some of the scrolls caused an immediate sensation. They were quickly dated from the 2d century BC through the 1st century AD by the script in which they were written and by archaeological investigations of the settlement near the Qumran caves.

The scrolls have had three major effects on historical and religious knowledge. The copies of biblical books, older than any others in existence, have illuminated many previously unclear passages of the standard Hebrew Bible, and have shown that the ancient Greek translations often reflect authentic Hebrew variations that had hitherto been lost. Second, the diversity of the literature has revealed the rich variety of Jewish tradition in antiquity, thus providing a context for understanding the development of early Judaism and Christianity. Third, knowledge about the Qumran community has been greatly increased. It has most often been identified as a type of Essene group, although some scholars are not convinced by this identification. The prevailing view is that the group moved to Qumran *c.*150–100 BC after a conflict with the ruling Hasmonean high priests in Jerusalem. If the events alluded to in the biblical commentaries are historical, the community and an early leader, the Teacher of Righteousness, experienced external oppression and also internal divisions.

The community considered itself to be the true Israel, zealously obeying biblical law as interpreted by its leaders and awaiting the coming of God to destroy all evil and purify Jerusalem. They were governed at various times by priests, overseers, and councils, and met in regular communal assemblies. Property was held in common, celibacy was probably practiced, and ritual purity and tithing rules were strictly observed. The members, who lived in caves within several miles of the main administrative center, kept apart from outsiders. Initiation was carried out in several stages. Behavior was governed by detailed instructions supported by penalties for disobedience, including expulsion.

Deadwood Deadwood (1990 pop., 1,830), a city in western South Dakota 32 km (20 mi) east of the Wyoming border, is the seat of Lawrence County. It is a commercial and processing center for the surrounding mining, lumbering, and livestock-raising area; tourism is also important because of Deadwood's location in the center of the Black Hills. Settled in the 1870s after gold was discovered nearby, Deadwood was a well-known frontier town and the home of Calamity Jane, Wild Bill Hickok, and Deadwood Dick.

deaf, education of the Education of the deaf was undertaken as early as the 16th century in Italy and Spain and the 18th century in England, France, and Germany. A clergyman, Thomas Hopkins Gallaudet, in 1817 established the first school for the deaf in the United States, now known as The American School for the Deaf, in Hartford, Conn. The first teacher, whom Gallaudet had brought from a French school for the deaf, was himself deaf. Several other states opened schools for the deaf in the first quarter of the 19th century. Oral teaching methods (teaching of speech and lip-reading skills) were used in the schools, which were established for children who had become deaf or who had lost their hearing in early childhood. These students, it was believed, needed oral



Finger spelling (right), *which employs a single-handed finger alphabet, was developed during the 18th century by Abbé Charles Michel de l'Épée. A sign language based on a two-handed alphabet* (left) *is also widely used. The different positions of the hands and fingers represent specific letters, making it possible for deaf people to communicate by spelling out words.*

methods to help preserve the speech communication skills they had acquired before losing their hearing. The methods of oral education developed in Germany and England were studied prior to the opening of the Clarke School in Northampton, Mass., and the New York Institution for Hearing Impaired Instruction (now the Lexington School for the Deaf) in New York City; these are considered the first oral schools for the deaf in the United States. Edward Minor Gallaudet, a son of Thomas Hopkins Gallaudet, became (1857) principal of the Columbia Institution for the Deaf and Dumb in Washington, D.C., which was later known as the National Mute College and eventually renamed Gallaudet College, then GALLAUDET UNIVERSITY. It was and is the only liberal-arts institution specifically for the deaf.

Alexander Graham BELL, the inventor of the telephone, was for many years a teacher of the deaf. Throughout the late 1800s, he and Thomas Hopkins Gallaudet debated the preferable method of instructing the deaf—the oral method or sign-language method or a combination of both. This controversy continues to the present time. A 1986 report from the United Nations Educational, Scientific, and Cultural Organization argued for the integration of sign languages into deaf education.

In 1985, 43,755 hearing-impaired elementary and high school students attended 762 schools and classes for the deaf in the United States. In addition, about 20,000 students with impaired hearing attended regular schools. Mainstreaming handicapped students into classes with nonhandicapped children, a relatively new venture, was promoted by the 1975 Education for All Handicapped Children Act, which mandated a free and appropriate public educational opportunity for the deaf in an environment as nearly normal as the individual's handicap permitted. The communication handicap of deafness is nevertheless a difficult one for both teacher and mainstreamed student and often inhibits the full integration of hearing and hearing-impaired students.

Gallaudet College and the National Technical Institute for the Deaf, which is part of Rochester (N.Y.) Institute of Technology, offer college-level instruction to the deaf. In addition, about 50 colleges have special programs for the hearing-impaired. The United States has long been in the forefront in providing opportunities for hearing-impaired people. With the growing number of college-educated deaf people, virtually every profession has become open to them.

deafness Deafness is the loss of the ability to hear because of disease, toxic drugs, trauma, or an inherited disorder. Deafness may be classified as conductive, sensorineural, or both.

A conductive hearing loss results from damage to those portions of the EAR which transmit sound vibrations in the air to the fluids of the inner ear, usually the eardrum (tympanic membrane) or the small bones (ossicles) of the middle-ear cavity. Ossicles conduct sound from the eardrum to the cochlea, but they cannot do so properly if the eardrum is perforated, if the middle-ear cavity fills with fluid, or if the bones become separated, are destroyed by disease, or are overgrown by a spongy bone. Sound intensity is reduced, although sound is not distorted. Such deafness can often be reversed by proper drug therapy or, in some cases, surgery.

Sensorineural hearing loss involves damage to the delicate sensory cells of the organ of Corti, which is located in the cochlea, or to the auditory nerves. It entails both distortion of sound and loss of sound intensity. Also, the hair cells of the organ of Corti and auditory nerve cells cannot regenerate; thus, sensorineural hearing loss is seldom reversible.

The hearing losses caused by salicylates, such as aspirin, and by the early stages of MENIERE'S DISEASE are reversible, however. The latter condition is characterized by an imbalance of fluid pressures within the inner ear. If this imbalance is corrected before hair-cell destruction has occurred, hearing will return to its former level. Sensorineural hearing loss is often accompanied by ear noise, or TINNITUS, a high-pitched ringing heard only by the patient. Because the inner ear has no pain fibers, damage is not accompanied by pain.

Hearing loss is usually measured by an instrument called an audiometer, which measures the weakest intensity (the threshold) at which a person can hear at most frequencies in the range of human hearing. The instrument is calibrated against the lowest intensity heard by normal humans at each frequency. Audiometry can determine the amount of hearing loss—whether it is conductive or sensorineural in nature, and how much of each type of damage has occurred.

See also: HEARING AID.

Deák, Ferenc [deh'-ahk, fair'-ents] Ferenc Deák, b. Oct. 17, 1803, d. Jan. 28, 1876, was a Hungarian political leader who is known primarily as the architect of the Compromise (*Ausgleich*) of 1867, which created the Dual Monarchy of AUSTRIA-HUNGARY. He had been actively involved in Hungarian politics from 1833 and was Hungary's minister of justice in 1848 (April–September), but he made his reputation by his able defense of Hungarian rights after 1849.

Deakin, Alfred [dee'-kin] Alfred Deakin, b. Aug. 3, 1856, d. Oct. 7, 1919, was the most outstanding prime minister of Australia in its early history. An able and eloquent lawyer, he entered the Victoria legislature in 1880. He advocated the unification of all the Australian colonies and was a leader at the federation conventions. Elected to the first Commonwealth (federal) parliament, Deakin became attorney general of Australia in 1901. He was prime minister three times (1903–04, 1905–08, 1909–10) and was responsible for national invalid and old-age pension acts.

Dean, Dizzy Jay Hanna Dean, b. Lucas, Ark., Jan. 16, 1911, d. July 11, 1974, was one of baseball's most colorful characters and a member of the flamboyant St. Louis Cardinal "Gas House Gang." A tall, lanky, right-handed pitcher, he averaged 24 wins a season from 1932 to 1936, leading the National League in strikeouts for 4 of 5 years. In 1934 he won 30 games and the NL Most Valuable Player award. His two World Series victories that season, combined with his brother Paul's two wins, gave the Cardinals the World Series championship. In the 1937 All-Star game Dean suffered a serious injury to his left toe, and his pitching effectiveness declined sharply. He last pitched for the Cubs during the 1940 season, bringing his lifetime record to 150 victories and 83 defeats. He was elected to the Hall of Fame in 1953.

Dean, James James Byron Dean, b. Marion, Ind., Feb. 8, 1931, d. Sept. 30, 1955, was an American actor whose film career had hardly begun when he was killed in a car crash. A cult figure even today, Dean triggered an outburst of teenage fan mania based on his second film, *Rebel Without a Cause* (1955), in which he played the moody, troubled son of a middle-class family. His first starring role, *East of Eden* (1955), and his third, *Giant* (completed 1956), added to the legend.

James Dean, the brooding youth hero of the 1950s, appears in a scene from Rebel Without A Cause *(1955). Although Dean starred in only three films, his death in 1955 set off a wave of mourning among movie fans.*

Deane, Silas Silas Deane, b. Groton, Conn., Dec. 24, 1737, d. Sept. 23, 1789, was an American diplomat in Paris during the American Revolution. The son of a Connecticut blacksmith, he became a successful lawyer and merchant and was active in the protest against the Stamp Act. As a member of the First and Second Continental Congresses, Deane helped organize the Continental Army. Because of his mercantile experience, Deane was sent to France in 1776 to sell American produce and buy supplies. Later he was joined by Benjamin Franklin and Arthur Lee (1740–92). Lee accused Deane of using public funds for private profit and insisted, contrary to Deane, that France did not expect payment for supplies provided through the agency of Caron de Beaumarchais. Deane was recalled (1778) to America under a cloud of suspicion, and his poorly kept records proved inadequate to exonerate him. No longer trusted, he left politics and died in England. In 1841–42 a congressional investigation cleared his name and compensated his heirs.

Dearborn Dearborn is a city on the River Rouge in southeastern Michigan, adjacent to Detroit. It has a population of 89,286 (1990). The home of Henry Ford, it is the site of Ford Motor Company's enormous River Rouge plant. Fair Lane, Ford's estate, is now part of the University of Michigan's Dearborn campus. Greenfield Village, built by Ford, has become a tourist attraction. It includes a museum of technology and about 100 historic buildings moved there from their original sites throughout the United States. Settled in 1795 as a coach stop between Detroit and Chicago, Dearborn grew during the 1920s after construction of the River Rouge plant.

Dearborn, Fort see Fort Dearborn

Dearborn, Henry Henry Dearborn, b. Hampton, N.H., Feb. 23, 1751, d. June 6, 1829, was an American general during the Revolutionary War and the War of 1812. He fought at Bunker Hill, Saratoga, and Monmouth and was on George Washington's staff at Yorktown. From 1801 to 1809 he was secretary of war. At the outbreak of the War of 1812, Dearborn was made commander of the northeastern front from Niagara to the Atlantic coast. His military ability had diminished, however, and after several major failures he was relieved (1813) of command.

Death, Dance of see Dance of Death

death adder The death adder, *Acanthopis antarcticus*, is a large venomous snake in the cobra family, Elapidae. It inhabits Australia and New Guinea and, unlike other cobras, resembles a viper in that it has a broad, triangular head and a short tail. Up to 80 cm (31.5 in) in length, the death adder is grayish brown with dark bands. Its small eyes, and scales protruding from the eyebrow, give a threatening appearance. A much feared snake, the death adder has extremely potent venom, and nearly 50 percent of untreated bites in humans result in death, attributed to respiratory arrest. The female is viviparous, typically bearing 10 to 12 live young.

death and dying Death is the cessation of life resulting from irreversible changes in cell metabolism. The science of the study of the death process is called thanatology, a term invented by Russian biologist Elie Metchnikoff. The field includes not only the biological changes associated with death but also the social, psychological, emotional, legal, and ethical factors that may be involved. The study of the biology of death is concerned with death processes in various organs and tissues and in the individual cells of which they consist. First consideration must in fact be given to the process of cell death.

The living cell is a thermodynamically unstable system. This means that without a continuous input of energy, a cell will degrade spontaneously into a nonliving collection of molecules. This energy is supplied by the synthesis of a high-energy compound called adenosine triphosphate, or ATP (see ATP). More than 90 percent of the ATP of most mammal cells is made in the cells by reacting oxygen with chemical compounds derived from glucose, a sugar, or from fatty acids. Arrest of the blood supply to any area of the body cuts off that area's nutrition and oxygen supply and interferes with the removal of wastes. This leads to a breakdown of the internal structure of the cell and to the inactivation of its enzymes.

The loss of oxygen is critical. Many cells have means of maintaining minimal nutrition for some time, but there is no means of storing oxygen. The changes following a momentary interruption of oxygen supply can be reversed, but irreversible changes result from longer periods of loss. Body cells vary widely in their survival potential. Neurons of the brain can last only five to eight minutes. Cells of the heart, kidneys, and liver can survive for about an hour. Skin cells may survive for several hours. These differences in survival potential are related primarily to differences in metabolic rate. Death of even large numbers of cells, such as in gangrene of a leg, does not necessarily lead to the death of a person. Death of the neurons of the BRAIN's cerebral cortex, however, destroys intellectual capacity, and loss of neurons in the midbrain and medulla destroys the brain center that controls breathing. This means that unless the person is placed on mechanical respirators, the remaining cells of the body will die shortly.

Definition of Death

For a long time, the definition of death as the arrest of heart action and irreversible breakdown of respiration was considered a fact that did not require legal definition. With advances in medical technology, however, the use of drugs and machines such as respirators enabled doctors to restore vital functions within minutes after they had stopped and, sometimes, to maintain them indefinitely. As a result, many medical authorities came to define death as the cessation of cerebral function (brain waves) as well as of respiratory and circulatory function. It was recognized that in some cases, such as when the brain is destroyed as a result of anoxia (oxygen deficiency), a person is no longer capable of thought processes, awareness, or responsiveness to stimuli and may be considered dead even though the heart continues to function.

Many hospitals today have adopted a definition of death that equates it with irreversible COMA. According to this definition a physician may assume that a person's brain is dead if it yields a flat ELECTROENCEPHALOGRAPH reading; one set of guidelines requires that two such readings be taken, one a day later than the first. This diagnosis is confirmed when further examination reveals characteristic signs of irreversible coma: unresponsiveness to all external stimuli, and lack of any sign of the normal reflexes controlled by the brain stem or the spinal cord. The hospital would then consider that it could withdraw supportive medical measures, on the assumption that nothing more can be done for the patient. Such decisions, however, can raise important questions of MEDICAL ETHICS. Many hospitals, as a result, have developed ethics committees to assist physicians and the families of patients in reaching these treatment decisions.

Legal Aspects

Legal as well as ethical considerations may also be involved in such matters. By the late 1980s in the United States, most states had legally declared brain death to be an essential part of the definition of death. The need for this move had become evident with the growth of organ transplant operations, because organs must be removed as quickly as possible from a dead person before they begin to deteriorate. Difficult legal questions were also being created, however, by those situations in which modern technology made possible the maintenance of life in otherwise irreversibly comatose or terminally ill patients. Various groups and individuals, as a result, have for a number of years been pressing for the legal "right to die," declaring that extraordinary life-sustaining treatments only prolong suffering. They have sought to establish this right, in particular, by means of so-called "living wills" that confer authority for withdrawal of such treatments upon family members, friends, or legal figures. By the late 1980s more than half of the states had recognized the legality of living wills, but the questions of EUTHANASIA that they involve—that is, the induction of gentle death by passive means—continue to be the center of numerous ethical and legal controversies.

Aside from medical implications, it may be necessary to know the exact time of death in cases of murder or in civil lawsuits involving liability, insurance, or inheritance of property. Many ways are available by which specialists can estimate the approximate time of death; for example, by the presence of *algor mortis* (the fall of body temperature, which occurs at a rate of 0.65° to 1.21° C/1.5° to 2.5° F per hour after death), or of *rigor mortis* (rigidity of muscles, beginning 5 to 6 hours after death).

The most important legal procedure following the death of a person is the official registration of death. All states in the United States require a death certificate, which constitutes legal proof of death. Causes of death usually recognized include natural causes, accident, suicide, and homicide.

Dying

Records of the cause of death in the United States indicate that most deaths are the result of chronic diseases such as heart disease, cancer, or diabetes mellitus, in which death is anticipated over months or years. Until the early 20th century, however, diseases were often masked by premature death from infectious diseases that have since been eradicated. Today most Americans die sometime after reaching age 65; it is estimated that the average dying person spends about 80 days during the last years of life in a hospital or nursing home.

A growing number of Americans have been seeking better ways to cope with death and dying. Several groups have organized HOSPICE programs in an effort to ease the pain, depression, and loneliness of terminal illness and to give psychological counseling to dying patients and their families. To be considered a true hospice, a care program must have the resources to provide home care, outpatient services, and hospitalization if required for control of physical symptoms; pain prevention or control is also part of hospice care.

Psychology of Dying

The Swiss psychiatrist Elisabeth Kübler-Ross found that many dying patients are comforted if someone sits and listens to their openly expressed fears and thoughts. She also observed that many dying patients, after the shock of learning of their condition, go through five psychological stages: denial, anger, bargaining, grieving, and acceptance. Patients may be assisted in reaching acceptance by the hospital staff's and family's openly talking about death when the patient so desires.

In the denial stage, the patient refuses to recognize reality and acts as if the disease did not exist. The patient may then become angry, resenting others who enjoy good health and blaming doctors and relatives for their inability to help. In the bargaining stage the patient tries to "buy time," often in the form of prayers asking for "one more year," in return for being a better person. This psychological stage, which is usually brief, is followed by the first true recognition of reality, and the patient then enters the stage of grief or depression, mourning the loss of his or her own life. In the final stage of acceptance, the patient may still be fearful and angry but is now prepared to die with peace and dignity.

death penalty see CAPITAL PUNISHMENT

death rate see DEMOGRAPHY

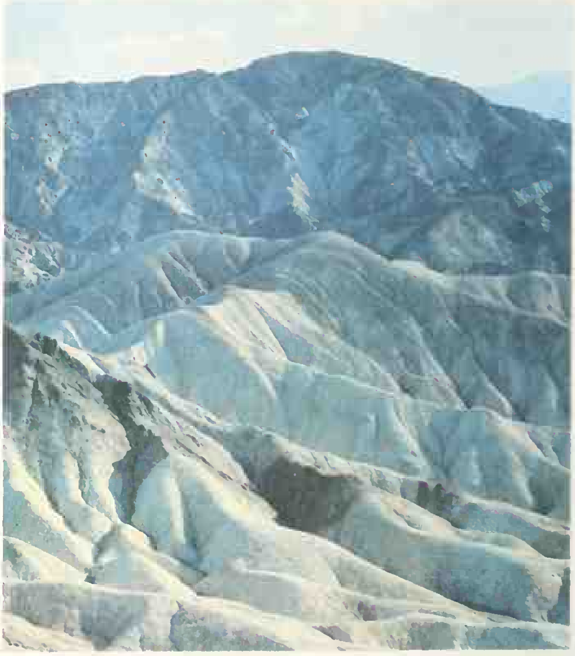
Death of a Salesman *Death of a Salesman* (1949), winner of the 1949 Pulitzer Prize for drama, is Arthur MILLER's best-known and most-important problem play. Symbolic and in part expressionistic, it challenges the American values concerning success held by the aging Willy Loman, who is here given individual as well as universal dimensions. Fired, Willy Loman tries to understand why he has failed as a traveling salesman, as a father, and as a husband. Flashbacks show him with his sons, Biff and Happy, his wife, Linda, and others, seeking but failing to realize the outsized dreams of his youth. Still holding on to false values of success that have both sustained and destroyed him, Willy Loman ultimately commits suicide.

Death Valley Death Valley is a desert basin in southeastern California, 225 km (140 mi) long and 8 to 24 km (5 to 15 mi) wide, between the Panamint Mountains to the west and the Amargosa Range to the east. It was named by gold-seekers, many of whom died crossing the valley during the 1849 gold rush. Death Valley National Monument, extending partly into Nevada, was established in 1933. Its area is nearly 7,721 km^2 (2,981 mi^2), of which 1,425 km^2 (550 mi^2) are below sea level. The lowest point in the valley is 86 m (282 ft) below sea level, which is the lowest elevation in the Western Hemisphere.

Death Valley is part of the Basin and Range province of the western United States, which consists of a series of fault-block mountains and intervening basins. It began to sink during the Miocene Epoch, perhaps 25 million years ago. The valley is the hottest region in North America; the highest U.S. air temperature ever recorded, 57° C (134° F), occurred there in 1913, and ground temperatures sometimes exceed 79.4° C (175° F). The Panamint Mountains block moist air and leave the valley proper with an average annual rainfall of only 38 mm (1.5 in). Furnace Creek and the Amargosa River carry mountain rains into the valley, but they are often dry. Prehistoric lakes left salt flats in the lowest areas, where nothing grows. The valley floor higher up consists of sand and salt grains that support coarse grass, mesquite, cacti, and poppies. Coyotes, kangaroo rats, horned toads, big-horn sheep, wild burros, and ravens inhabit the region.

Although gold, silver, lead, and copper have been mined, Death Valley is best known for borax, discovered in 1873 and brought out by mule teams until richer deposits were found elsewhere. Mining settlements have become ghost towns that now help make the region a tourist attraction.

California's Death Valley, seen here at Zabriskie Point, descends to the lowest point of elevation in the Western Hemisphere, 86 m (282 ft) below sea level.



DeBakey, Michael [duh-bayk'-ee] Michael Ellis DeBakey, b. Lake Charles, La., Sept. 7, 1908, a surgeon, has made numerous contributions to the field of cardiovascular surgery, including ANEURYSM resectioning and the replacement of parts in major arteries. DeBakey invented a special pump that became an essential part of the HEART-LUNG MACHINE now in use and, with associates, developed a Dacron-lined heart assister to be used temporarily when treating patients with cardiac failure.

debenture see BOND

Deborah Deborah was a biblical prophetess and a leader (judge) of Israel. The Song of Deborah, celebrating a victory over the Canaanites (see JUDGES, BOOK OF), is among the oldest Hebrew literary compositions.

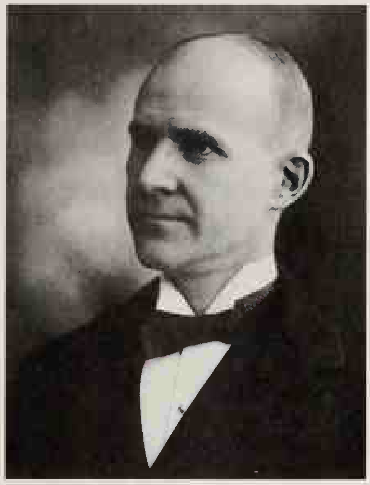
Debrecen [deb'-ret-sen] Debrecen is the capital of Hajdú-Bihar County, Hungary. Situated on the southwest edge of the Great Plain region east of the Tisza River, it is Hungary's second largest city, with a population of 220,000 (1989 est.). Machinery, furniture, pharmaceuticals, and railroad cars are produced there. The Great Protestant Church, built during the 14th century, dominates the former marketplace. The Protestant College (now Lajos Kossuth University) was founded in 1549.

Known since the 13th century as a market, the city was a center of Hungarian Protestantism during the 16th century. It remained semiautonomous under 16th- and 17th-century Turkish occupation. During the unsuccessful attempt to throw off Austrian rule in 1848–49, Lajos KOSSUTH declared Hungarian independence in Debrecen. During World War II the city was a provisional capital of Hungary.

Debs, Eugene V. Eugene Victor Debs, b. Terre Haute, Ind., Nov. 5, 1855, d. Oct. 20, 1926, was a railroad labor leader and for many years the standard-bearer of socialism in the United States. In 1875 he helped form a local of the Brotherhood of Locomotive Firemen. Becoming a national officer and editor of its magazine, he rebuilt the firemen's brotherhood and helped organize other railroad brotherhoods. In 1893 he founded the industrial American Railway Union, which became the nation's largest union. It took part in the PULLMAN STRIKE of 1894, which was broken by a blanket court injunction and federal troops.

Jailed for 6 months thereafter, Debs read the writings of Karl KAUTSKY and was visited in jail by Victor BERGER. Under these influences he moved toward socialism and helped found the Social Democratic party of America in 1897, the SOCIALIST PARTY in 1901, and the INDUSTRIAL WORKERS OF THE WORLD in 1905. He was a presidential candidate in 1900, 1904, 1908, 1912, and 1920.

Debs saw industrial unions as necessary both to combat organized business interests and to provide a political base for revolutionary—but not necessarily violent—change. A vociferous opponent of all war except the international battle for socialism, he was tried and given a 10-year prison sentence in 1918 for violating the Espionage Act. After a pardon by President Warren G. Harding in 1921, he threw the support of the Socialists behind Robert La Follette in the presidential election of 1924.



Eugene V. Debs, a founder of and spokesman for the U.S. Socialist party, ran five times as its candidate for the presidency. During World War I, Debs, a pacifist, spoke out against the prosecutions made under the Espionage Act of 1917, a stand that cost him his citizenship and 3 years in prison.

debt A debt, in finance, is the obligation to pay someone a sum of money. Usually a debt arises from a transaction in which one person (the debtor) receives something (goods, services, or money) from another (the creditor) in return for a promise to pay later. Most debts include a promise to pay INTEREST at a specified rate.

If debtors fail to meet their obligations, creditors may take legal action to force payment or seize property in lieu of payment. In one procedure a judgment is obtained against a debtor, requiring that payment be made. If the debtor then fails to pay, state laws provide for the seizure of the debtor's property to pay the sum owed, plus the legal costs incurred. In ancient Greece and Rome the insolvent debtor could be sold into slavery to make good a debt. Imprisonment for debt was ended during the 19th century in Great Britain and the United States.

See also: ATTACHMENT (law); BANKRUPTCY; BOND; INSTALLMENT PLAN.

debt, public see NATIONAL DEBT

Debussy, Claude Achille Claude Debussy, b. Saint-Germain-en-Laye, Aug. 22, 1862, d. Paris, Mar. 25, 1918, was the creator and leading exponent of French musical impressionism. At the Paris Conservatory, he studied piano with Antoine François Marmontel and composition with Ernest Guiraud.

From 1887 on, Debussy confined his activity to composition, rarely appearing in public as a performer. Al-

Claude Debussy was the foremost innovative French composer of the late 19th century. He experimented with harmony and created new and strikingly original sounds in his orchestral compositions. Debussy excelled at composing for the piano.

though he associated little with musicians, he enjoyed the company of the leading impressionist poets and painters who gathered at the home of the poet Stéphane Mallarmé. Their influence is felt in Debussy's first important orchestral work, *Prelude to the Afternoon of a Faun* (1892–94), inspired by Mallarmé's poem, *L'Après-midi d'un faune.* This work established the style of impressionist music and initiated Debussy's most productive period, which lasted nearly 20 years. During that time he composed the orchestral suites *Nocturnes* (1893–99), *La Mer* (1903–05), and *Images* (1906–09); most of his piano music, including the two books of *Préludes* (1910–13); the incidental music to *The Martyrdom of St. Sebastian* (1911); the ballet *Jeux* (1912); a number of songs and some chamber music; and his one completed opera, *Pelléas et Mélisande* (1892–1902), based on Maurice Maeterlinck's drama. About 1910, Debussy developed cancer, which sapped his strength during his last years. He died during the bombardment of Paris by German artillery.

Debussy's style was one of the most important influences on 20th-century music. He rejected the overblown forms and the harmonic style of the post-Wagnerians such as Gustav Mahler and Richard Strauss. He preferred understated effects similar to those achieved by the French impressionist painters and poets. *Pelléas et Mélisande,* the most significant impressionist opera, has been called a masterpiece of understatement. He wanted his music to sound improvisatory, as though it had not been written down. Debussy's piano music is the most important since Chopin's. He created a subtle pianistic style that made new demands on performing technique, and the shifting, blurred sonorities of the style were achieved by a new use of the damper pedal. His best-known composition is probably "Clair de lune" (Moonlight) from "Suite Bergamasque" (1890–1905) for piano.

Debye, Peter [dee-by'] The Dutch-born American physical chemist Peter Joseph William Debye, b. Mar. 24, 1884, d. Nov. 2, 1966, was awarded the Nobel Prize for chemistry in 1936 for his contribution to the study of molecular structure. Debye developed methods for determining the actual distances of atoms from each other in a molecule (see PLASMA PHYSICS), as well as for determining the distribution of an electric charge within a molecule.

decadence [dek'-uhd-uhnts] The term *decadence* is often used to describe a decline of moral, ethical, or artistic standards. In literary history it specifically applies to AESTHETICISM and SYMBOLISM—late-19th-century movements in France and England marked by their amoral sentiments, perversely sensual or exotic imagery, and belief in art for art's sake. In France the movement's credo was echoed in the journal *Le Décadent* (1886–89), the poetry of Charles BAUDELAIRE and Paul VERLAINE, and J. K. HUYSMANS's novel *À Rebours* (1884; trans. as *Against the Grain*), which helped create a vogue for expressions of satiety and weariness, sometimes accompanied by a longing for religious certainty and asceticism. In England aestheticism was cultivated by the poets Ernest DOWSON and Arthur Symons and by Oscar WILDE in his play *Salomé;* (1893). These writers were frequent contributors to the *Yellow Book* (1894–97), a periodical that published the drawings of Aubrey BEARDSLEY.

Decameron [dee-kam'-uh-rahn] The *Decameron,* a collection of stories composed by Giovanni BOCCACCIO between 1348 and 1353, consists of traditional medieval tales, especially brief erotic narratives of the FABLIAU type. The frame is set in Florence during the plague of 1348. Ten young noblemen and women fleeing the city for the healthier air of their country villas decide to pass the time by telling one story each for ten days. They thus produce 100 stories that give the book its title, from Greek *deka* ("ten") and *hemera* ("day"). The *Decameron* is notable for the skillful movement among the characters, the settings of the frame, and the tales themselves. The stories have greatly influenced English literature, particularly the works of Chaucer.

decathlon The decathlon, a standard contest at many major track-and-field championships, was introduced (1912) as an official Olympic event at the Olympic Games in Stockholm and was won by Jim THORPE. Consisting of ten events, the decathlon is a test of an athlete's speed, agility, endurance, and strength. The decathlon program—divided into two days of competition since 1936, before which it was one day—consists of events held in a particular order. First-day events are: 100-meter dash, long jump, shot put, high jump, and 400-meter run; those held on the second day are: 110-meter high hurdles, discus throw, pole vault, javelin throw, and 1,500-meter run. A competitor is allowed three throws for the weight events, three tries or attempts at heights in the jump events, and three false starts in the track events, and is considered out of the competition if any event is missed. Scoring is tabulated according to performance tables, which are changed periodically to keep pace with improving track-and-field performances. In Olympic competition the winner of this grueling event, deemed the world's greatest athlete, is the one who scores the most points. Because of the scoring system, it is possible for an athlete to win a decathlon competition without actually placing first in any of the ten events.

Decatur [di-kayt'-uhr] Decatur (1990 pop., 83,885) is a city in central Illinois on the Sangamon River. The seat of Macon County, as well as an industrial and rail center, the city is surrounded by farmland on which corn and soybeans are grown. Decatur was founded in 1829. Abraham Lincoln practiced law there from 1847 to 1857. The damming of the Sangamon River created Lake Decatur.

Decatur, Stephen [dee-kay'-tur] Stephen Decatur, b. Sinepuxent, Md., Jan. 5, 1779, d. Mar. 22, 1820, was an American naval officer who distinguished himself in the WAR OF 1812 and in the wars with the BARBARY STATES. Commissioned a midshipman in 1798, Decatur served (1798–1800) in the West Indies during the Quasi-War with France. He was ordered to the Mediterranean during the TRIPOLITAN WAR and led a small band of sailors into Tripoli harbor on Feb. 16, 1804. There they boarded and set fire to the captured American frigate *Philadelphia* before escaping with only one man wounded. The British admiral Horatio Nelson hailed the exploit as the "most bold and daring act of the age," and Decatur was promoted to captain.

During the War of 1812, Decatur, in the frigate *United States,* defeated (Oct. 25, 1812) the British frigate *Macedonian* in one of the war's most renowned single-ship engagements. He was subsequently unable to leave American waters because of the British blockade. When he tried to run the blockade out of New York in January 1815, his ship was captured by a British squadron. By this time the war had ended, however, and he was repatriated. In June 1815 he returned to the Mediterranean and dictated terms of peace to Algiers, Tunis, and Tripoli, thereby concluding the last American war with the Barbary States. At a banquet celebrating this achievement, Decatur chauvinistically toasted: "Our country! In her intercourse with foreign nations may she always be in the right; but our country, right or wrong." A practiced and ardent duelist, Decatur accepted a challenge from James Barron, a suspended captain on whose court-martial Decatur had sat, and was killed in the duel.

The American naval commander Stephen Decatur won fame for his exploits in the Tripolitan (1801–05) and Algerine (1815) wars, which ended the depredations of the Barbary pirates on U.S. merchant shipping in the Mediterranean. (Chicago Historical Society.)

Deccan Plateau [dek'-ahn] The Deccan Plateau is a vast upland coextensive with most of the Indian peninsula. The term *deccan,* which means "south," is sometimes used to designate all of peninsular India; the word *plateau* refers only to the central tableland. Triangular in shape, the Deccan Plateau is enclosed by the Western and Eastern GHATS and by several ranges across the base of the triangle in the north, which wall the plateau off from the rest of India. The plateau, averaging about 610 m (2,000 ft) in elevation, is one of the world's oldest landmasses. The plateau is drained by three river systems—the Cauvery, Godavari, and Krishna—whose valleys are densely populated. The largest cities are POONA, HYDERABAD, and BANGALORE.

Decembrists [dee-sem'-brists] The Decembrists were members of Russia's first revolutionary movement, which attempted and failed to overthrow the government of NICHOLAS I in December 1825. Chiefly young army officers, the revolutionaries were divided in their objectives; they favored varying degrees of representative government, and some wanted abolition of serfdom.

Taking advantage of some confusion as to which brother of Emperor ALEXANDER I (who died on Dec. 1, 1825) would succeed him, the Decembrists pledged the troops of St. Petersburg to the older brother, Constantine, unaware that he had secretly renounced his rights to the throne in favor of his younger brother, Nicholas. On December 26, three regiments in St. Petersburg massed in the Senate Square and refused to pledge allegiance to Nicholas. They were fired on, and about 80 soldiers and civilian spectators were killed. Five leaders of the rebellion were hanged, some were imprisoned, and many others were banished to Siberia.

decibel see SOUND AND ACOUSTICS

deciduous plant [di-sij'-uh-wuhs] Deciduous plants are those TREES and shrubs which shed all or nearly all of their leaves each year. In contrast, EVERGREEN plants retain their leaves for prolonged periods. The most common deciduous plants are broad-leaved trees of the temperate zones (see BIOME). Certain needle-leaved conifers, such as the larch, are deciduous. The leaves of these plants generally fall when conditions become cold and dark, so that the plants avoid losing water through the leaves. Similarly, such tropical trees as the broad-leaved *Eucalyptus* and the needle-leaved *Casuarina* drop their leaves just before a seasonal hot, dry period. Some broad-leaved trees and shrubs of humid tropical rain forests, such as mahogany and teak, do not need to shed their leaves.

Leaves fall after the abscission cell layer forms at the base of each leaf stem in response to a plant hormone known as abscisic acid. Cells of this layer separate and weaken the base of the stem, and the leaf then can be broken from the plant by the wind. Another cell layer forms over the wound, sealing off the stem. Leaf buds that were present during the plant's dormancy grow after the winter or arid season ends.

decimal A decimal is a number written in BASE 10. Numbers in base 10 are expressed by use of the decimal system, a base-and-place numeration system, with each place representing a power of 10 and zero used as a place holder. For example, the number 1,980 means $(1 \times 10^3) + (9 \times 10^2) + (8 \times 10^1) + (0 \times 10^0)$, where $10^0 = 1$. This system was invented by the Hindus and brought to Europe by the Arabs before 1200, although it was not universally adopted until the 17th century.

decision theory Decision theory is the study of how decisions actually are made and how they ought to be made. The two situations are studied in two different branches of decision theory, descriptive and normative. Descriptive decision theory describes and explains how people choose among actual options; as such, it is an empirical subject that uses experimental and survey methods and is of interest to psychologists, economists, political scientists, and business people. Normative, or prescriptive, decision theory concerns rational choices rather than actual choices. It prescribes the course of action that should be selected in order to achieve a specified goal. As such, it is a deductive discipline investigated by mathematicians, logicians, and theoretical statisticians.

Games in decision theory represent a particular class of decisions under uncertainty in which other players determine the relevant states of nature—conditions that determine the consequences of a chosen action and are assumed to be mutually exclusive and exhaustive. Games in decision theory are distinct from those in GAME THEORY, in which games are played against intelligent opponents—as in a game of chess—and not states of nature.

Decker, Mary Mary Teresa Decker (Slaney), b. Bunnvale, N.J., Aug. 4, 1958, held—at one time or another from the mid-1970s to the late 1980s—almost every women's world track record from 800 m to 10,000 m. Going into the 1990s she still held the U.S. records for most of those events. Decker's achievements are notable, but the Sullivan Award winner (1982) is perceived as not quite having lived up to her great promise. Although she was the 1983 world champion at 1,500 and 3,000 m, Decker failed to win Olympic medals in either 1984 and 1988. Decker has spent much of her career beset by injuries.

Declaration of Independence The Declaration of Independence, approved by the CONTINENTAL CONGRESS on July 4, 1776, is a statement of the principles that two days earlier had led Congress to vote for the independence of the American colonies from Great Britain. It was designed to influence public opinion, both at home and abroad, especially in France, to which the United States looked for military support. The drafting of the document was entrusted to a committee consisting of John ADAMS, Benjamin FRANKLIN, Thomas JEFFERSON, Roger SHERMAN, and Robert R. Livingston (see LIVINGSTON family). Because of Jefferson's reputation as a literary craftsman, the committee assigned the task to him, and with minor exceptions it is exclusively his work.

Jefferson drew upon a long oppositionist tradition in Britain, as well as the English and French ENLIGHTENMENT, as sources for his ideas; his language and the structure of his argument, however, most closely parallel the natural-rights theories of John LOCKE. In justifying England's GLORIOUS REVOLUTION of 1688, Locke had advanced the contract theory of government, arguing that all "just" governments are founded on consent and are designed solely to protect people in their inherent rights to life, liberty, and property. Radical proponents of this theory had used it to justify civil disobedience whenever government encroached on any of the specified rights; the more conservative Jefferson held that resistance is justified only when a consistent course of policy shows an unmistakable design to establish tyranny. King George III bore the brunt of Jefferson's attack, although earlier protests had been directed at Parliament and the governing ministry. This focus was necessary to establish a contractual justification of independence, as the colonists had consistently maintained that their only contract was with the crown.

In one key respect Jefferson used NATURAL LAW instead of natural-rights theory, substituting "the pursuit of happiness" for "property" in the trinity of inalienable rights. In this change, derived from the Swiss legal philosopher Emerich de Vattel, he emphasized public duty rather than (as the language seems to indicate) personal choice, for natural law theory is that happiness is attainable only by diligent cultivation of civic virtue. Two passages in Jefferson's draft were rejected by the Congress—an intemperate reference to the English people and a scathing denunciation of the slave trade. The document was otherwise adopted without significant change, and formal signing by 56 members of Congress began on Aug. 2, 1776.

THE DECLARATION OF INDEPENDENCE

In Congress, July 4, 1776,
THE UNANIMOUS DECLARATION OF THE
THIRTEEN UNITED STATES OF AMERICA

When in the Course of human events, it becomes necessary for one people to dissolve the political bands which have connected them with another, and to assume among the Powers of the earth, the separate and equal station to which the Laws of Nature and of Nature's God entitle them, a decent respect to the opinions of mankind requires that they should declare the causes which impel them to the separation.

We hold these truths to be self-evident, that all men are created equal, that they are endowed by their Creator with certain unalienable Rights, that among these are Life, Liberty, and the pursuit of Happiness.

That to secure these rights, Governments are instituted among Men, deriving their just powers from the consent of the governed.

That whenever any Form of Government becomes destructive of these ends, it is the Right of the People to alter or to abolish it, and to institute new Government, laying its foundation on such principles and organizing its powers in such form, as to them shall seem most likely to effect their Safety and Happiness. Prudence, indeed, will dictate that Governments long established should not be changed for light and transient causes; and accordingly all experience hath shown, that mankind are more disposed to suffer, while evils are sufferable, than to right themselves by abolishing the forms to which they are accustomed. But when a long train of abuses and usurpations, pursuing invariably the same Object, evinces a design to reduce them under absolute Despotism, it is their right, it is their duty, to throw off such Government, and to provide new Guards for their future security.

Such has been the patient sufferance of these Colonies; and such is now the necessity which constrains them to alter their former Systems of Government. The history of the present King of Great Britain is a history of repeated injuries and usurpations, all having in direct object the establishment of an absolute Tyranny over these States. To prove this, let Facts be submitted to a candid world.

He has refused his Assent to Laws, the most wholesome and necessary for the public good.

He has forbidden his Governors to pass Laws of immediate and pressing importance, unless suspended in their operation till his Assent should be obtained; and when so suspended, he has utterly neglected to attend to them.

He has refused to pass other Laws for the accommodation of large districts of people, unless those people would relinquish the right of Representation in the Legislature, a right inestimable to them and formidable to tyrants only.

He has called together legislative bodies at places unusual, uncomfortable, and distant from the depository of their public Records, for the sole purpose of fatiguing them into compliance with his measures.

He has dissolved Representative Houses repeatedly, for opposing with manly firmness his invasions on the rights of the people.

He has refused for a long time, after such dissolutions, to cause others to be elected; whereby the Legislative powers, incapable of Annihilation, have returned to the People at large for their exercise; the State remaining in the mean time exposed to all the dangers of invasion from without, and convulsions within.

He has endeavoured to prevent the population of these States; for that purpose obstructing the Laws of Naturalization of Foreigners; refusing to pass others to encourage their migrations hither, and raising the conditions of new Appropriations of Lands.

He has obstructed the Administration of Justice, by refusing his Assent to Laws for establishing Judiciary powers.

He has made Judges dependent on his Will alone, for the tenure of their offices, and the amount and payment of their salaries.

He has erected a multitude of New Offices, and sent hither swarms of Officers to harass our People, and eat out their substance.

He has kept among us, in times of peace, Standing Armies without the Consent of our legislatures.

He has affected to render the Military independent of and superior to the Civil power.

He has combined with others to subject us to a jurisdiction foreign to our constitution, and unacknowledged by our laws; giving his Assent to their Acts of pretended Legislation:

For quartering large bodies of armed troops among us:

For protecting them, by a mock Trial, from Punishment for any Murders which they should commit on the Inhabitants of these States:

For cutting off our Trade with all parts of the world:

For imposing Taxes on us without our Consent:

For depriving us in many cases, of the benefits of Trial by Jury:

For transporting us beyond Seas to be tried for pretended offences:

For abolishing the free System of English Laws in a neighbouring Province, establishing therein an Arbitrary government, and enlarging its Boundaries so as to render it at once an example and fit instrument for introducing the same absolute rule into these Colonies:

For taking away our Charters, abolishing our most valuable Laws, and altering fundamentally the Forms of our Governments:

For suspending our own Legislatures, and declaring themselves invested with power to legislate for us in all cases whatsoever.

He has abdicated Government here, by declaring us out of his Protection and waging War against us.

He has plundered our seas, ravaged our Coasts, burnt our towns, and destroyed the Lives of our people.

He is at this time transporting large armies of foreign mercenaries to compleat the works of death, desolation and tyranny, already begun with circumstances of Cruelty & perfidy scarcely paralleled in the most barbarous ages, and totally unworthy the Head of a civilized nation.

He has constrained our fellow Citizens taken Captive on the high Seas to bear Arms against their Country, to become the executioners of their friends and Brethren, or to fall themselves by their Hands.

He has excited domestic insurrections amongst us, and has endeavoured to bring on the inhabitants of our frontiers, the merciless Indian Savages, whose known rule of warfare, is an undistinguished destruction of all ages, sexes and conditions.

In every stage of these Oppressions We have Petitioned for Redress in the most humble terms: Our repeated Petitions have been answered only by repeated injury. A Prince, whose character is thus marked by every act which may define a Tyrant, is unfit to be the ruler of a free people.

Nor have We been wanting in attention to our British brethren. We have warned them from time to time of attempts by their legislature to extend an unwarrantable jurisdiction over us. We have reminded them of the circumstances of our emigration and settlement here. We have appealed to their native justice and magnanimity, and we have conjured them by the ties of our common kindred to disavow these usurpations, which would inevitably interrupt our connections and correspondence. They too have been deaf to the voice of justice and of consanguinity. We must, therefore, acquiesce in the necessity, which denounces our Separation, and hold them, as we hold the rest of mankind, Enemies in War, in Peace Friends.

We, therefore, the Representatives of the united States of America, in General Congress, Assembled, appealing to the Supreme Judge of the world for the rectitude of our intentions, do, in the Name, and by Authority of the good People of these Colonies, solemnly publish and declare, That these United Colonies are, and of Right ought to be Free and Independent States; that they are Absolved from all Allegiance to the British Crown, and that all political connection between them and the State of Great Britain, is and ought to be totally dissolved; and that as Free and Independent States, they have full Power to levy War, conclude Peace, contract Alliances, establish Commerce, and to do all other Acts and Things which Independent States may of right do. And for the support of this Declaration, with a firm reliance on the Protection of Divine Providence, we mutually pledge to each other our Lives, our Fortunes and our sacred Honor.

JOHN HANCOCK.

New Hampshire
Josiah Bartlett,
Wm. Whipple,
Matthew Thornton.
Massachusetts-Bay
Saml. Adams,
John Adams,
Robt. Treat Paine,
Elbridge Gerry.
Rhode Island
Step. Hopkins,
William Ellery.
Connecticut
Roger Sherman,
Sam'el Huntington,
Wm. Williams,
Oliver Wolcott.
Georgia
Button Gwinnett,
Lyman Hall,
Geo. Walton.
Maryland
Samuel Chase,
Wm. Paca,
Thos. Stone,
Charles Carroll
of Carrollton.
Virginia
George Wythe,
Richard Henry Lee,
Th. Jefferson,
Benja. Harrison,
Ths. Nelson, Jr.,
Francis Lightfoot Lee,
Carter Braxton.
New York
Wm. Floyd,
Phil. Livingston,
Frans. Lewis,
Lewis Morris.
Pennsylvania
Robt. Morris,
Benjamin Rush,
Benja. Franklin,
John Morton,
Geo. Clymer,
Jas. Smith,
Geo. Taylor,
James Wilson,
Geo. Ross.
Delaware
Caesar Rodney,
Geo. Read,
Tho. M'Kean.
North Carolina
Wm. Hooper,
Joseph Hewes,
John Penn.
South Carolina
Edward Rutledge,
Thos. Heyward, Junr.,
Thomas Lynch, Junr.,
Arthur Middleton.
New Jersey
Richd. Stockton,
Jno. Witherspoon,
Fras. Hopkinson,
John Hart,
Abra. Clark.

declination In astronomy, declination is the angular distance between a celestial object and the celestial equator (see COORDINATE SYSTEMS, astronomy). Magnetic declination is the angular deviation of a compass from due geographic north (see EARTH, GEOMAGNETIC FIELD OF).

Decline and Fall of the Roman Empire, The History of the see GIBBON, EDWARD

Decline of the West, The see SPENGLER, OSWALD

decomposition In chemistry, decomposition is a type of chemical reaction in which a compound is broken down into simpler compounds or into the constituent elements of the compound.

See also: DISSOCIATION (CHEMISTRY); REACTION, CHEMICAL

decompression sickness see BENDS

decongestant drugs Decongestants are drugs used to shrink swollen mucosa. They function by acting on the sympathetic nervous system to constrict blood vessels. When applied locally as drops or a spray, amphetamine, ephedrine, hydroxyamphetamine, mephentermine, methoxamine, and phenylephrine, among others, are effective in relieving nasal congestion, respiratory ALLERGIES, or sinusitis, although aftercongestion may follow. Epinephrine is the most suitable drug for treating congestions of the conjunctiva. When given orally, some decongestants have good effects on allergic rhinitis. Decongestants are often combined with other agents such as antihistamines, antipyretics, analgesics, antitussives, or expectorants; benefits, however, depend largely on the other drugs.

deconstruction Deconstruction is a theory about language and literature that developed in the 1970s, in large part as a reaction to the primacy of STRUCTURALISM and SEMIOTICS in literary criticism. Its initial premises were first formulated by the French philosopher and critic Jacques DERRIDA, whose works converted a number of U.S. academics who, in turn, have established different schools of deconstruction—feminist deconstruction, for example.

What most characterizes deconstruction is its notion of *textuality*, a view of language as it exists not only in books, but in speech, in history, and in culture. For the deconstructionist, language constitutes everything. The world itself is "text." Language shapes humanity and creates human reality. (A reality that cannot be named or described is illusory, at best.) Yet, upon close examination, words seem to have no necessary connection with reality or with concepts or ideas.

Related to textuality, the notion of *intertext* refers to the broader cultural background, the context that saturates the text with innumerable concepts, conventions, figurations, and codes. Given the numerous hidden links of a text to its cultural and social intertext, the text's content and meaning are, essentially, indeterminate. Texts, therefore, are unreadable, and the practice of interpretation may be defined as *misreading*.

Derrida's deconstructions of Western thinkers from Plato to Martin Heidegger attack what he calls "logocentrism," the human habit of assigning truth to *logos*—to spoken language, the voice of reason, the word of God. Derrida finds that logocentrism generates and depends upon a framework of two-term oppositions that are basic to Western thinking, such as being/nonbeing, thing/word, essence/appearance, presence/absence, reality/image, truth/lie, male/female. In the logocentric epistemological system the first term of each pair is privileged (TRUTH/lie, MALE/female). Derrida is critical of these hierarchical polarities and seeks to take tradition apart by reversing their order and displacing, and thus transforming, each of the terms—by putting them in slightly different positions within a word group, or by pursuing their etymology to extreme lengths, or by substituting words in other languages that look and sound alike. Extending the work of Derrida, feminist critics have deconstructed the "phallocentric" pair male/female. Feminists in general see phallocentrism as fundamental to the larger "social text" of Western logocentric society, which, shaped by language, has given women secondary sexual, economic, and social roles.

decorations see MEDALS AND DECORATIONS

decorative arts The term *decorative arts* rather loosely refers to many objects that serve a practical purpose as well as a decorative one. The design of furniture, textiles, ceramics, glassware, jewelry, apparel, architectural decor, and the various folk arts all fall into this category. Many artists have also produced decorative art: for example, Raphael created tapestry designs and Picasso produced paintings on ceramics. Architects such as Robert Adam in 18th-century Britain and Frank Lloyd Wright in the 20th-century United States considered INTERIOR DESIGN as part of the total architectural plan and designed the furnishings for many of their buildings.

decretals [dih-kreet'-ulz] Decretals were papal letters written in response to questions about church government and discipline in Rome during early Christian times. They had the force of law in all regions under the pope's jurisdiction. They were first systematically compiled in the *Decretum Gratiani* (Gratian's Decretals, *c.*1140). This work became the basis for future compilations of CANON LAW.

deduction Deduction is a method of logical reasoning, as well as the conclusion reached by use of such a method. The deductive method is the method of proof that is used in any situation for which there exists a set of underlying assumptions (AXIOMS or postulates). Not all methods of proof are deductive, however. A statement can be supported by the inductive method, which uses examples in an attempt to derive a general truth (see INDUCTION).

Any conclusion reached by the deductive method must be true in all circumstances in which the assumptions are true. In each area of knowledge that has a set of underlying assumptions, the deductive method is used to discover as many consequences as possible. If some of the consequences do not fit the observations, then revisions of the assumptions are considered in an effort to make the theoretical consequences compatible with the observations.

See also: LOGIC.

deed A deed is an instrument that, when signed and delivered, transfers TITLE to land from one person to another. Three kinds of deeds are used in the United States. In the full covenant and warranty deed the seller guarantees that he or she has and can transfer valid title to the land, and stands ready to warrant and defend the buyer's rights. In a bargain and sale deed with covenant against grantor's acts, the seller (grantor) guarantees that no action on his or her part has clouded title to the land, but that he or she cannot be responsible for any acts of a former owner that may have caused defects in the title. In a quitclaim deed the seller makes no promises concerning the validity of the title. This deed simply transfers whatever rights the seller has, good or bad, in the land, and the buyer, having been put on notice, cannot sue the seller for damages if title to the land is later found to be invalid.

In most real estate transactions the buyer is self-protected against possible claims of third parties to the property by having a title company search the local land records. A buyer may also purchase title insurance against the possibility that some defect in the deed may later be discovered.

Deep-Sea Drilling Project The Deep-Sea Drilling Project (DSDP) was a scientific program for drilling cores of sediment and basaltic crust beneath the deep oceans and recovering them for study. The drilling began in 1968, using the ship *Glomar Challenger* (see OCEANOGRAPHY), and ended in 1983. The DSDP was funded primarily by the National Science Foundation and was managed for a consortium of oceanographic laboratories (JOIDES) by the Scripps Institution of Oceanography.

The DSDP, which was succeeded in 1984 by the OCEAN DRILLING PROGRAM, was itself a successor to the unsuccessful Mohole Project, an attempt to drill a hole deep enough to reach the Earth's mantle. One major accomplishment of the DSDP was to corroborate geomagnetic evidence of SEAFLOOR SPREADING, thereby authenticating PLATE TECTONICS as a model of crustal geodynamics. Cores taken from the Pacific and Indian oceans can be studied at Scripps and at LAMONT-DOHERTY GEOLOGICAL OBSERVATORY.

deep-sea life The area of the world's oceans called the deep sea is the largest habitat for life on Earth. The deep-sea environment includes all ocean waters beyond the edge of the CONTINENTAL SHELF and below the level of light penetration (see OCEAN AND SEA). It includes more than 90% of the ocean volume. Nevertheless, this region remains the least-known environment on Earth, because of its inaccessibility.

Environmental Characteristics

The deep-sea environment is best characterized as extremely constant at any one depth. Except for near-surface waters it is cold and in complete darkness. The shallower portions vary in temperature depending on latitude, but most are below 10° C (50° F); the temperature decreases with depth, but below 3,000 m (10,000 ft) it is about 3° C (about 37° F) everywhere.

Salinity is constant in the deep sea and varies little throughout all latitudes. Oxygen is present in sufficient amounts to sustain life in all deep-sea areas except for the few, isolated OCEANIC TRENCHES. In many areas, however, an oxygen-minimum zone exists between 500 and 1,000 m (1,600 and 3,300 ft) as the result of biological activity and the lack of interchange between this layer and overlying waters richer in oxygen. Food is also scarce. Because of the lack of photosynthetic activity, the environment must receive its food from organic material sinking from the lighted surface waters or transported from land areas. The only exception is the production of organic matter by bacteria around HYDROTHERMAL VENTS.

The most variable environmental factor is pressure. Because water depths vary from a few hundred to more than 10,000 m (33,000 ft), and because pressure increases at a rate of 1 atmosphere for each 10 m (33 ft) of depth, pressures range from 20 to more than 1,000 atmospheres.

Life Forms and Adaptations

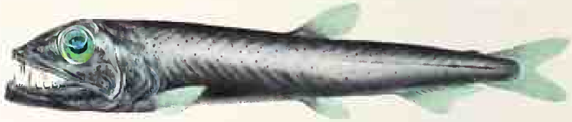
With the exception of most plants, which cannot exist in the absence of light, the deep sea contains representatives of virtually all the known phyla. The organisms are often highly modified from those seen in shallower waters, both in anatomy and in life history.

In general, pelagic (open-ocean) life forms show more special adaptations than do benthic (bottom-dwelling) forms. Certain colors are characteristic of pelagic organisms: fishes tend to be black, crustaceans bright red, and jellyfish deep purple. Another adaptation is size: most deep-sea fishes tend to be much smaller than their shallow-water relatives. A few exceptions exist, however; pelagic invertebrates—particularly members of crustacean groups such as COPEPODS, ostracods, and mysids—are often much larger.

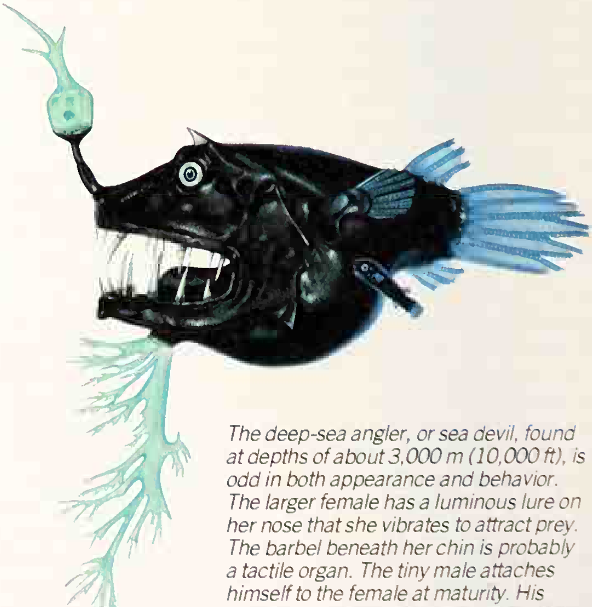
The lack of light also has its effects. Fishes of the shallower parts of the deep sea often have very large eyes relative to their size, suggesting that they respond to the minimal light present in the upper zones. Both fishes and invertebrates in these zones often possess light-producing organs (see BIOLUMINESCENCE). These organs may be important in species and sexual recognition, in attracting prey or repelling predators, in camouflage, or in other ways not yet understood.

In response to the scarcity of food, many deep-sea fishes have large mouths that enable them to swallow prey that is larger and wider than themselves. In addition, they often have formidable curved teeth to ensure that the prey does not escape. Many fishes also have greatly expanded guts for the digestion of meals larger than themselves. Another result of food scarcity is that the number of individuals of any given species living in the deep sea is usually quite low, which may make finding a mate for breeding purposes difficult. Certain species have adapted to this by having the males become parasitic on the females shortly after the hatching of the males; the life cycle of the ANGLERFISH is an example.

Because of pressure effects, fishes tend to increase in water content with depth and to decrease in lipids and protein; crustaceans also show protein decrease. In other words, the flesh of deep-sea animals tends to be jellylike and the skeleton minimal. As a result the fishes are more buoyant and thus less dependent on the swim bladder,



Omosudis lowei, *of the hammerjaw family, is a predaceous fish with a powerful bite. Its widely hinged jaw enables it to eat oversize fish. It is about 12.5 cm (5 in) long and lives at depths of from 200 to 1,000 m (660 to 3,300 ft).*



The deep-sea angler, or sea devil, found at depths of about 3,000 m (10,000 ft), is odd in both appearance and behavior. The larger female has a luminous lure on her nose that she vibrates to attract prey. The barbel beneath her chin is probably a tactile organ. The tiny male attaches himself to the female at maturity. His bloodstream fuses to hers, providing him sustenance. His other organs, except the reproductive, degenerate, and he becomes simply a source of sperm.

The predaceous Atlantic viperfish, found at depths of 500-2,000 m (1,650–6,600 ft), has luminous organs and long, needle-sharp teeth with which it spears its victims.

Fishes of the genus Dolichopteryx, *which grow to lengths of about 10 cm (4 in), have tubular eyes with binocular vision. By focusing both eyes on the same object, these fishes may gain extra sensitivity and depth (or distance) perception, thus enabling them to see better in poorly lit water. Tubular eyes have evolved in a number of fishes that tend to inhabit the lower mesopelagic, or "twilight," zone at depths of 500-1,000 m (1,600–3,300 ft).*

which is almost nonexistent among many species. The weakened body markedly reduces swimming speed and agility, however; many deep-sea fishes are relatively sluggish.

Ecology

Relatively little is known of the ecology of deep-sea communities. Benthic communities can be better described than the pelagic ones simply because most benthic forms do not move and can thus be better observed. The substrate in most of the deep sea is a soft ooze. The dominant large organisms of this ooze are usually various species of SEA CUCUMBERS; brittle stars are also common, as are small crustaceans such as ISOPODS and AMPHIPODS. Burrowing into the substrate are various POLYCHAETE worms. Fishes are present, but their mobility makes it difficult to estimate their numbers and importance as predators of the invertebrates.

Whereas most benthic forms feed on materials drifting down through the sea, virtually all pelagic animals are carnivores in the deep sea. In the upper layers many of these animals undergo a diurnal migration, moving up toward the surface at night and returning to the depths during the day. This behavior likely has to do with food-getting.

Perhaps the most exciting deep-sea discovery of life forms in the 20th century has been that of the hydrothermal-vent communities. At these vents, hot and sulfide-enriched water is produced. The sulfides are oxidized by bacteria, and the energy released is used to synthesize organic compounds. These areas are thus not dependent on food raining down; as a result, a whole fauna has developed around the vents.

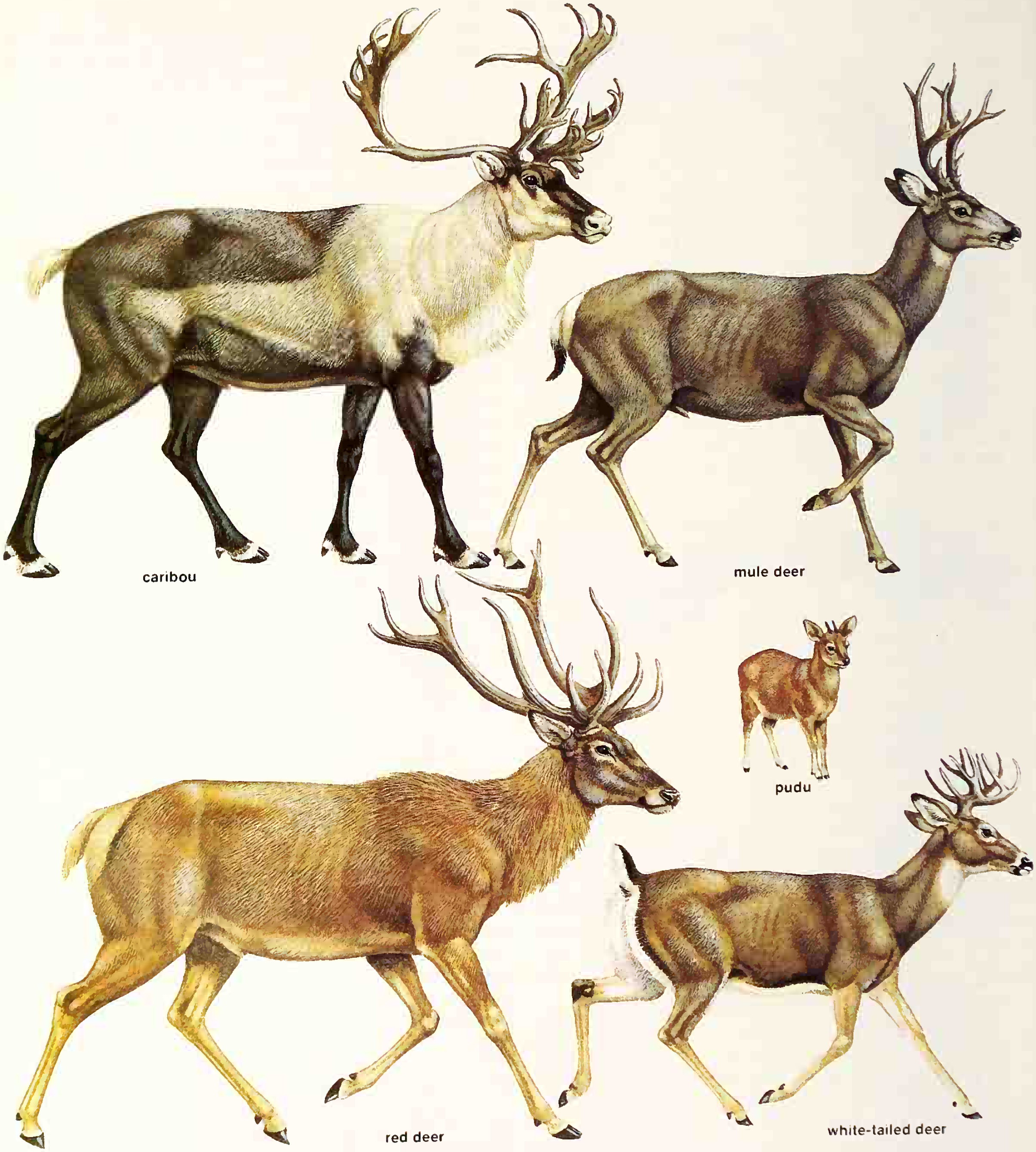
deer The deer is a hoofed, ruminant mammal in the Cervidae family, order Artiodactyla. The family consists of 17 genera and about 53 species. Native to all parts of the world except Australia, Antarctica, central and southern Africa, New Zealand, and Madagascar, deer are the only animals that grow antlers. They have adapted to virtually every land habitat, from dry deserts to woodlands, prairies, marshes, and Arctic regions.

Deer have a common origin with giraffes. They appeared during the Oligocene Epoch, becoming separated from giraffes during the Miocene Epoch, 24 million to 6 million years ago. Most present-day species of deer evolved during the Pliocene Epoch, 6 million to 2 million years ago.

Appearance. Antlers are borne only by male deer, except for the REINDEER, genus *Rangifer* (see also CARIBOU), both sexes of which bear antlers. Both sexes of the Chinese water deer, *Hydropotes,* and the musk deer, *Moschus,* lack antlers. Antlers are appendages of the skull and are constructed of solid bone tissue supported by permanent skin-covered pedicels, unlike the hardened-skin horns of antelopes and cattle. The male deer sheds its antlers every year between January and April, following the mating season. Among young deer the first set of antlers are usually short spikes. As the deer matures, the antlers become longer and acquire branches, or "points."

Deer have long, slender legs, each with two toes tipped by strong, curved hooves. Two upper toes, called dewclaws, do not touch the ground, although their prints can be seen in snow. Deer vary in color from whitish gold through shades of brown almost to black. Some adult species in Europe and Asia have white spots; in most species young deer, called fawns, have spots. Like cattle, goats, and antelopes, deer are ruminants, or cud chewers, and have a four-chambered stomach.

The largest deer are the North American MOOSE, the male, or bull, of which stands as tall as 2.3 m (7.5 ft) at the shoulder and weighs up to 810 kg (1,786 lb). The smallest deer, the pudu of the Andes, are about 30 cm (12 in) tall and weigh 6.8 kg (15 lb). North American ELK (wapiti) stand about 1.5 m (5 ft) tall, weigh up to 350 kg (770 lb), and are the second largest North American deer. Through game management the white-tailed deer of North America, once hunted almost to extinction, have become the most numerous large game animal on the



The variety of deer is revealed in these five species, drawn to scale to indicate their relative size. The caribou is known in Europe as the reindeer. Caribou migrate over broad areas in search of lichen, their primary food. The mule deer inhabits western North America. The tiny pudu lives in remote regions of South America, sometimes as high as 4,000 m (13,100 ft) in the Andes; its numbers have diminished because of overhunting. The red deer, possibly identical to the American elk, inhabits most of Europe and Asia. The white-tailed deer, found from Canada to northern South America, varies in size from north to south in the United States. A big northern buck may weigh 145 kg (320 lb), whereas a large deer in the Florida Keys may not reach 40 kg (90 lb).

continent. This deer weighs about 90 kg (200 lb) and stands 1.1 m (3.5 ft) tall. A dwarf variety is the Key deer of Florida, which weighs 23 kg (50 lb) and is less than 76 cm (2.5 ft) tall. Other North American deer include the mule deer, found in the forests, and the caribou, found in Arctic and sub-Arctic regions.

Among the deer of Europe and Asia are the moose (smaller than the American moose, and called elk), reindeer, fallow deer, red deer, axis deer, muntjac, and musk deer. Père David's deer of China are extremely rare and are probably extinct in the wild; they are being bred in zoos with the aim being to return stock to their native territory in northern China.

Behavior. Most deer associate in groups, although a few are solitary, usually during the nonmating season. Typically, male deer gather a harem during the breeding season. Some, such as the reindeer, migrate.

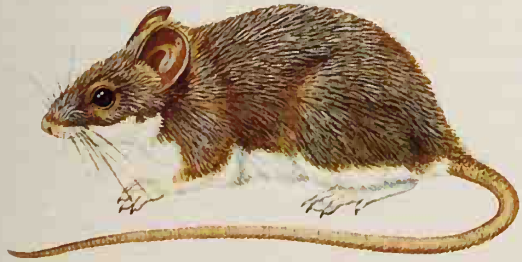
Deer mate during the autumn, and the doe usually gives birth to one or two fawns in the spring. The gestation period ranges from 160 days among musk deer to about 10 months among roe deer, genus *Capreolus.* In some species the doe must hide its young for days or weeks until they are able to walk and run. Caribou and reindeer calves follow their mothers within a matter of hours. Before rutting season, bucks rub their antlers against trees in an effort to remove the soft, hairy skin (velvet) that covers growing antlers. During breeding season, bucks use their antlers as weapons in fights for the favor of females, and to fend off predators.

Deer are fast runners and swimmers. When frightened, a deer may remain motionless, waiting for the danger to pass.

Deer typically feed on grass, bark, leaves, twigs, and sprouts, although they may also eat moss, lichens, and fungi. Water plants are favored by moose and swamp deer.

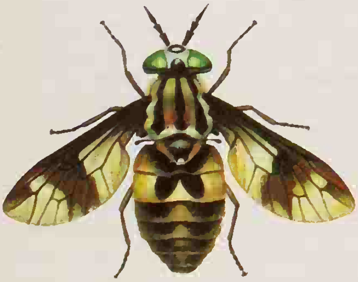
deer mouse Deer mice, or white-footed mice, constitute some 55 species in the genus *Peromyscus*, family Cricetidae, order Rodentia. These numerous mice weigh 14 to 57 g (0.5 to 2 oz) and are 9 to 17 cm (3.5 to 6.7 in) long, not including the tail, which may be up to 20 cm (8 in) long. The eyes and ears are relatively large. The fur is soft, dense, and varied in color. Deer mice are found from Alaska to northern South America.

The deer mouse, a species of North American white-footed mice, resembles the European long-tailed field mouse.



Deere, John John Deere, b. Rutland, Vt., Feb. 7, 1804, d. May 17, 1886, was an early manufacturer of farm implements. In 1837 he left Vermont, where he had been a blacksmith, and moved to Grand Detour, Ill., where he invented a sturdy new PLOW with a steel share. With a partner, Deere began manufacturing the "Grand Detour plow." In 1846 he sold his interest and opened a new factory in Moline, Ill. As the business grew, Deere & Co. began manufacturing cultivators and other farm equipment.

deerfly The deerfly is a member of the genus *Chrysops* in the HORSEFLY family, Tabanidae. Female deerflies are bloodsuckers and may be serious pests to humans and animals, for they are carriers of such diseases as ANTHRAX and TULAREMIA. The male, which feeds on nectar and pollen, usually can be distinguished from the female by the lack of separation between the eyes. Deerflies are about the size of houseflies, with dark brown or black bodies, dark markings on the wings, and brilliantly colored eyes.



The deerfly, a large fly closely related to the horsefly, has dark bands of color on its wings. The female is a pest that bites and sucks the blood of animals and people.

deerhound see SCOTTISH DEERHOUND

defamation Defamation is the injuring of a person's good name or reputation by false and malicious statements that subject the person to ridicule, contempt, shame, or suspicion. Defamation, unlike criticism, invades the private life of an individual and causes a loss in prestige and standing. The right to privacy and the right to freedom from defamation differ in that the former directly concerns a person's peace of mind, whereas the latter concerns mainly his or her reputation. No legal cause of action called defamation exists, although one person may sue another for libel or slander. Libel is defamation expressed in print, writing, pictures, or signs. Slander is defamation by word of mouth, but the slanderous words must be spoken in the presence of someone other than the person slandered.

Words are *defamatory per quod* if they may be considered defamatory only with factual support showing that they libel the plaintiff. Words are *defamatory per se* if, by themselves, they damage the reputation of the person to whom they are applied.

The U.S. Supreme Court ruled in *New York Times Company* v. *Sullivan* (1964) that the 1st Amendment disallows libel judgments against the critics of public officials or public figures unless actual malice can be shown. Some subsequent rulings narrowed the definition of public figure and otherwise eased the restrictions placed on libel suits by the 1964 decision. In *Hustler* v. *Falwell* (1988), however, the Supreme Court strongly reinforced that decision and extended its standard of actual malice to suits in which injury to mental well-being, rather than reputation, is claimed.

In Great Britain false and damaging statements made against public figures (as well as private individuals) are libelous regardless of their intent.

See also: FREEDOM OF THE PRESS; FREEDOM OF SPEECH.

defense, national National defense is that aspect of a country's FOREIGN POLICY which is concerned with preventing or withstanding military attacks against itself or its allies and with the military defense of its vital interests abroad. The threat of force is always present in international politics. In this century, not only have there been two catastrophic global wars, but smaller international conflicts, wars of independence, and civil wars have been almost continuous since World War II. For decades the ideological conflict between the United States and the USSR and the threat of nuclear war made every military confrontation a potential disaster.

Defense Needs. In the period of the COLD WAR, the United States and the USSR were by far the world's most formidable military powers. The USSR saw its defense needs as uniquely stringent, because it faced two potential adversaries, the United States and China, on two fronts. Moreover, its leaders believed that the capitalist states of the West were bent on the destruction of Communism. The United States and its allies, on the other hand, felt equally threatened by Soviet expansionism. Each side built up huge arsenals of nuclear weapons, hoping that the prospect of mutual destruction would prevent the outbreak of another world war.

Certain other states have developed a high degree of military readiness in response to local or regional conditions. Israel, for example, which has been engaged in repeated wars with the Arab states since 1948, devotes almost 15% of its gross national product (GNP) to national defense. Tensions in the Middle East have made that area a primary market in the international WEAPONS TRADE. In Southeast Asia, another turbulent region, Vietnam has one of the strongest armies in the world, used as a deterrent to China and to exert control over Kampuchea and Laos.

States in more stable regions are likely to concentrate less on national defense. Some Western European countries, for example, have relied more on the security provided by the North Atlantic Treaty Organization (NATO) and the U.S. nuclear "umbrella" than on military spending.

Constituents of Defense. National defense includes not only military strength but also such factors as intelligence gathering and CIVIL DEFENSE. The ability to mobilize the economy for war is also crucial. Countries maintain their defenses in different ways. China, although it has a nuclear force, relies more on manpower and less on equipment than the more technically advanced powers. The U.S. Army, by contrast, is rather small in relation to the global position of the United States, which has depended mainly on nuclear deterrence and superior technology. Alliances may be elements in a defense program. During the cold-war era, the defense of the Western European nations depended on NATO, and that of the Communist countries of Eastern Europe on the Warsaw Treaty Organization.

Besides the United States, four nations deploy nuclear armaments: the USSR, China, France, and Great Britain. India also has nuclear capability; Israel, South Africa, and Pakistan probably do as well. The United Nations–sponsored Nuclear Non-Proliferation Treaty, which seeks to prevent the spread of nuclear armaments to countries that do not already have them, has had only limited success. (See also ARMS CONTROL and NUCLEAR STRATEGY.)

Defense and Society. Defense needs impose demands on a country's economy and people. During World War II most countries adopted CONSCRIPTION. The United States (since 1973) and Great Britain (since 1960) have returned to voluntary military service, although the United States registered young men in 1980 for a possible future draft. Many other countries draft army regulars.

The expense of equipping and supporting a military force is enormous. During the Reagan administration (1981–89), increases in defense spending contributed to record U.S. budget deficits that prompted passage of the Gramm-Rudman budget-balancing law of 1985. The problems experienced by the Soviet economy during the same period made it more and more difficult for the USSR to bear the burden of maintaining its huge military establishment.

The relaxation of tensions between East and West that began in the late 1980s opened up the prospect for significant reductions in military spending on both sides.

Defense, U.S. Department of Located in the Pentagon, the U.S. Department of Defense directs the operations of the Army, Navy, Marine Corps, and Air Force. The department is headed by the secretary of defense.

The principal military authority in the department is the Joint Chiefs of Staff, composed of a chairman and the chiefs of staff of the Army, Navy, and Air Force. On matters concerning the Marine Corps, the commandant of the Marine Corps participates as an equal member. Under the joint chiefs are the unified commands, such as the Space Command and the Atlantic, European, and Pacific Commands, and the specified commands, such as the Strategic Air Command. The Army, Air Force, and Navy are separately organized as departments with their own secretaries, under the direction of the secretary of defense. The Marine Corps is included in the Department of the Navy.

The Department of Defense was organized in 1949 as an outgrowth of the National Security Act of 1947, replacing the separate War and Navy departments with a unified military establishment.

defense counsel A defense counsel in United States law is a trial lawyer specializing in criminal law who defends a person accused of committing a crime. From the moment of arrest, every person is entitled to have a lawyer's advice. Any communication between a lawyer and a client is privileged, and a lawyer cannot be forced to divulge it. Defendants who cannot afford to pay for legal advice are entitled to LEGAL AID in cases where conviction might result in a prison sentence.

Counsel represents a defendant at every stage of the CRIMINAL JUSTICE process, from arraignment before a magistrate, to APPEAL following a conviction. Counsel recommends to a defendant whether or not to accept a PLEA BARGAIN, and uses every legal device to strengthen the client's case before a jury in the event of a TRIAL.

defense mechanisms Defense mechanisms are psychological coping techniques by means of which feelings, fantasies, and other contents of the mind are kept from consciousness in order to avoid the extreme anxiety associated with them. Defense mechanisms are strongly emphasized by psychiatrists trained in Freudian PSYCHOANALYSIS, who have amassed a vast amount of anecdotal and clinical evidence on them. Experimental psychologists have found evidence for the existence of most defense mechanisms. The most frequently encountered defense mechanisms are defined briefly below.

In denial, a person refuses to recognize the seriousness of an emotionally threatening situation, and perceives it as less threatening. Repression is the selective forgetting of stressful memories; the person is not consciously aware that the material is being repressed. Reaction formation, for which little experimental evidence exists, is a tactic for reinforcing repression by adopting behaviors that are the opposite of repressed behaviors. Suppression, or avoidant thinking, on the other hand, is a strategy for avoiding stressful thoughts by actively blocking them with other, unstressful thoughts. In projection, a person denies having undesirable personality traits and assigns those traits to another person. Displacement involves expressing negative emotions toward one person or object when they should, in fact, be directed at a different person or object. In regression, a person reverts to immature behavior when faced with an emotional problem. Identification concerns taking on the desirable personality traits of another person. Compensation is a coping strategy by which the individual strives to overcome feelings of inferiority by devoting great effort toward overcoming perceived inferior traits. In sublimation, a person deals with unacceptable impulses by becoming involved in socially acceptable activities. Isolation involves a dispassionate response to threatening situations. Undoing refers to a person trying to compensate for an inappropriate act by subsequently committing another, more appropriate one.

The English novelist and pamphleteer Daniel Defoe based his most famous novel, Robinson Crusoe, *on a true story. Defoe, who had faced bankruptcy several times, died in 1731 while hiding from a creditor.*

Defoe, Daniel [dee-foh'] Best known for the novel ROBINSON CRUSOE (1719), Daniel Defoe, b. 1660, d. Apr. 24, 1731, was an English writer of social criticism, satire, and novels. Literary historians consider *Robinson Crusoe* the first successful English novel and Defoe one of the originators of realistic fiction.

Encountering bankruptcy in 1692, Defoe turned to writing, an avocation he had already undertaken in the anonymous verse satire *A New Discovery of an Old Intreague* (1691). His early works also included *An Essay Upon Projects* (1697), containing ideas for improving society. Defoe wrote at first principally on political subjects. His popular poem in support of William III, *The True-Born Englishman, A Satyr* (1701), answered objections to the king's foreign birth. After William's death in 1702, Defoe published *The Shortest Way with Dissenters* (1702), an ironic pamphlet that attacked the new government's restrictions on religious freedom.

Until 1719, Defoe wrote about politics and economics for various periodicals, and from 1704 to 1713 he singlehandedly produced his own paper, *The Review.* During these years he also wrote *The True Relation of the Apparition of One Mrs. Veal* (1706), a ghost story he had investigated and that displayed his talents for reporting and realistic narrative, talents apparent in the works of fiction for which he is remembered, including *Robinson Crusoe,* followed by adventure stories such as *Memoirs of a Cavalier* and *Captain Singleton* (both 1720). With *Moll Flanders, A Journal of the Plague Year,* and *Colonel Jack* (all 1722), Defoe established himself securely as a writer of adventure fiction that mixed physical and psychological realism. His later works, such as *Roxana* and *A New Voyage around the World* (both 1724), treated characters within the framework of a recurrent theme—the difficulties of surviving in a threatening world of recognizably modern economic forces.

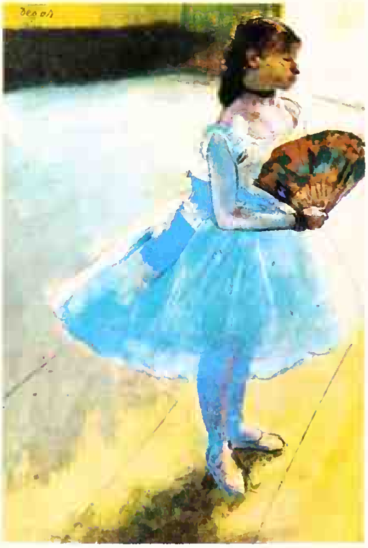
In addition to his fiction, Defoe continued to write extensively on politics, trade and commerce, religion and morality—including the occult—travel, and geography. Important sources for an understanding of 18th-century

England, his works include *Religious Courtship* (1722), *The Complete English Tradesman* (1725), *A Tour Thro' the Whole Island of Great Britain* (1724–26), and *The Political History of the Devil* (1726).

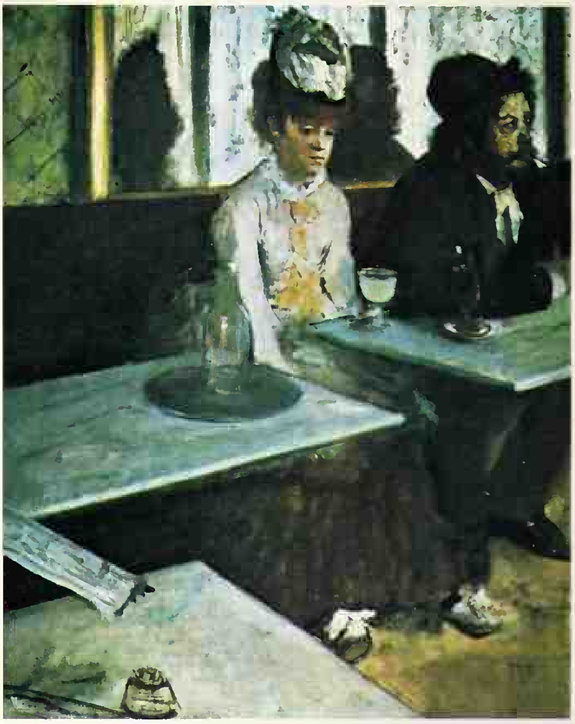
Degas, Edgar [duh-gah'] The art of Hilaire Germain Edgar Degas, b. Paris, July 19, 1834, d. Sept. 26, 1917, reflects a concern for the psychology of movement and expression and the harmony of line and continuity of contour. These characteristics set Degas apart from the other impressionist painters (see IMPRESSIONISM), although he took part in all but one of the eight impressionist exhibitions between 1874 and 1886.

Degas's idol was the painter Jean Auguste Ingres, whose example pointed him in the direction of a classical draftsmanship, stressing balance and clarity of outline. In portraits of his family and friends and a number of historical subjects, Degas combined classical and romantic styles. In Paris, he came to know Édouard Manet, and in the late 1860s he turned to contemporary themes, painting both theatrical scenes and portraits with a strong emphasis on the social and intellectual implications of props and setting.

In the early 1870s the female ballet dancer became his favorite theme. He sketched from a live model in his studio and combined poses into groupings that depicted rehearsal and performance scenes in which dancers on stage, entering the stage, and resting or waiting to perform are shown simultaneously and in counterpoint, often from an oblique angle of vision. On a visit in 1872 to Louisiana, where he had relatives in the cotton business, he painted *The Cotton Exchange at New Orleans* (finished 1873; Musée Municipal, Pau, France), his only picture to be acquired by a museum in his lifetime. Other subjects from this period include the racetrack, the beach, and café interiors.



Edgar Degas explored his favorite theme, the world of the ballet, in such brightly colored pastels as Dancer with a Fan *(1879). (Private collection, Texas.)*



In Absinthe *(1876), a scene of 19th-century Parisian life, Edgar Degas chose an asymmetrical composition to create spatial depth. Degas asked friends to pose in this picture, portraying their mood of melancholy detachment. (Louvre, Paris.)*

After 1880, PASTEL became Degas's preferred medium. He used sharper colors and gave greater attention to surface patterning, depicting milliners, laundresses, and groups of dancers against backgrounds now only sketchily indicated. For the poses, he depended more and more on memory or earlier drawings. In 1881 he exhibited a sculpture, *Little Dancer* (a bronze casting of which is in the Museum of Fine Arts, Boston), and as his eyesight failed thereafter he turned increasingly to sculpture, modeling figures and horses in wax over metal armatures. These sculptures remained in his studio in disrepair and were cast in bronze only after his death.

degree, academic An academic degree is a title conferred by a college or university certifying the completion of a course of study or an honorary award given in recognition of achievement. The master's and the doctor's degrees (originally synonymous) grew out of receiving the advanced student into the guild of teachers at the University of Paris and other medieval institutions starting about the 13th century. The bachelor's degree, awarded on the completion of the first part of the curriculum, signified that the student, if he or she continued, was qualified to serve as a teaching apprentice.

United States. The actual significance of a degree in the United States can be determined only by referring to the catalog of a specific university or college. The bachelor's degree is awarded upon completion of a 4-year undergraduate program or its equivalent. The Bachelor of Arts (B.A. or A.B.) and the Bachelor of Science (B.S.) degrees are granted in the liberal arts. No consistent difference exists between the two, although the B.S. degree presupposes a heavier concentration in the sciences. Bachelor's degrees are also awarded by professional schools in many professional fields.

The Master of Arts (M.A. or A.M.), Master of Science (M.S.), and professional master's degrees are awarded upon completion of 1 or 2 years of work at the postbaccalaureate level. The Doctor of Philosophy (Ph.D.) requires from 3 to 5 years of study beyond the bachelor's degree and includes the preparation of a dissertation. Other common first professional degrees include the Doctor of Jurisprudence (J.D.) in law after 3 years of graduate study, and the Doctor of Medicine (M.D.) after 4.

In recent years a number of nontraditional institutions have been authorized by states to grant degrees. The accomplishment recognized by such degrees, and the worth of these degrees, varies from the equivalent of traditional degrees at recognized universities to meaningless certificates issued by "degree mills." Honorary degrees are bestowed by many colleges and universities on prominent people in recognition of their achievements.

Europe. The structure of higher education and of academic degrees varies widely from country to country. In England the 3- or 4-year B.A. is more specialized than its U.S. counterpart. The M.A. degree may be awarded after an examination is taken or a dissertation written, but Oxford and Cambridge graduates can obtain an M.A. from these universities upon payment of fees after a certain number of years. The Ph.D. is earned after 2 or 3 years' study followed by completion of a thesis. In Scotland the M.A. is the first, or primary, degree conferred.

In West Germany the *Doktor* (Ph.D.) degree is usually the earned degree at the university level, although students may leave earlier, taking the *Staatsexamen* to qualify for teaching at a secondary school. In France the *baccalauréat* is the certificate given upon leaving secondary school. The *license* is roughly equivalent to the American bachelor's degree, and the *doctorat* is given at two levels, *doctorat du troisième cycle* and *doctorat d'état*.

degree-day A degree-day is a unit of measurement used in several fields of technology where temperature changes are of importance. Such fields include heating, AIR-CONDITIONING, construction, and agriculture. Basically, one degree-day is the deviation by 1 F degree (0.55 C degree) of the average outdoor temperature, for a given day, from a chosen reference temperature. The fuel industry commonly uses a reference "minimum comfort" temperature of 65° F (18° C) in its formulas for estimating energy needs for heating enclosed areas. Thus, if the outdoor temperature averaged 5 F degrees (2.77 C degrees) below that temperature on a given day, this would represent an accumulation of five degree-days. Other reference temperatures are used in other fields. In determining power needs for air-conditioning units, for example, the reference temperature employed is usually 75° F (24° C).

dehydration (food) Preserving certain foods by drying them is among the oldest methods of FOOD PRESERVATION. For example, fruits that are high in sugar content, such as dates and grapes, have been sun-dried in warm climates since they were first cultivated.

Modern methods of dehydration can preserve a wide range of foods. Techniques include tunnel-drying, microwave drying (see MICROWAVE OVEN), FREEZE-DRYING, spray-drying, and foam-drying. The purpose of all dehydration methods is to prevent microbial growth.

dehydration (physiology) Dehydration is the loss of body water. All METABOLISMS require water to survive. Animals in arid regions have body mechanisms that protect against water loss and make maximum use of water (see CAMEL; DESERT LIFE). The egg stage of the life cycle is dehydration-resistant in some animals. Various animals can enter a dormant condition during dry periods. Microscopic arthropods called water bears can survive in this way for years.

Dehydration in humans results from lack of food and drink and from sweating, urination, and vomiting and diarrhea. The first symptom of dehydration is thirst. Water present in the blood, lymph, and interstitial fluid is then lost. This loss affects the proper functioning of the heart, central nervous system, and organs containing smooth muscle. Finally, intercellular water is lost, which upsets vital chemical processes in the cells. If water is not restored to the body, death will usually occur within a few days.

Deimos [dy'-muhs] Deimos is the smaller and more distant of the two satellites of the planet Mars (the other is PHOBOS), both discovered by Asaph Hall in 1877. Deimos is about 11 by 12 by 15 km (6.8 by 7.5 by 9.3 mi) and is roughly ellipsoidal. It orbits at a mean distance of 23,500 km (14,600 mi) and has a sidereal period of 30 hr, 18 min. Deimos's albedo is only 0.05, which makes its surface as dark as the Moon's darkest regions. *Mariner 9* revealed (1971) that the surface of Deimos has craters.

Deir el-Bahri [dayr el-bah'-ree] Deir el-Bahri (Dayr al-Bahri), opposite Luxor on the west bank of the Nile River, is the site of two ancient temples of Upper Egypt. The site's name (Arabic for "monastery by the sea or river") is derived from the Coptic monastery built there in the 7th century but long since dismantled in the course of modern excavations. Cliffs at the site form a natural semicircle into which Mentuhotep II of the Middle Kingdom built (*c.*2050 BC) his mortuary temple. Elaborate colonnaded terraces and ramps were erected at the entrance to the chamber tomb, which is sunk deep into the side of the cliffs. During the New Kingdom the mortuary temple of Queen HATSHEPSUT of the 18th dynasty, designed by the architect Senemut to resemble that of Mentuhotep II, was constructed (*c.*1478 BC) alongside the earlier temple. A famous series of reliefs include scenes of Hatshepsut's trading expedition to the land of Punt. Objects from both temples are contained in the Metropolitan Museum of Art in New York City.

deism [dee'-izm] *Deism* is a term applied to the thought of 17th- and 18th-century freethinkers who sought to maintain a belief in God while making it compatible with the rationalism of the ENLIGHTENMENT. Believing that the development of science was compatible with a belief in God as first cause, creator, and source of universal and immutable laws, they felt that immutable laws ruled out miracles or divine intervention. They also argued that moral law could be derived from NATURAL LAW rather than from REVELATION.

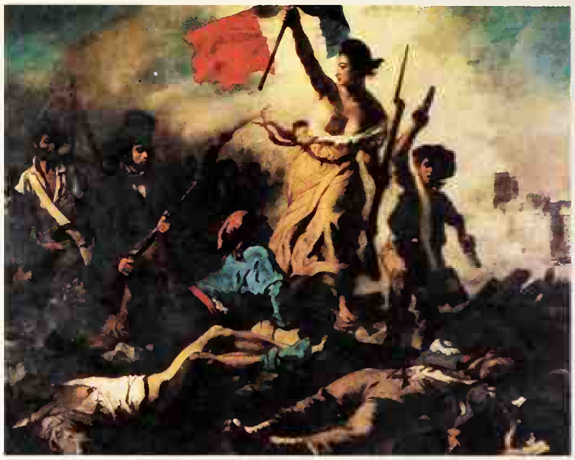
Deism must be distinguished from theism, which claims not only that God created the world but that he actively intervenes in its operation through miracles. Because of its denial of divine intervention, deism is sometimes referred to as the "absentee landlord" theory.

Lord Herbert of Cherbury (1583–1648) is considered the founder of English deism. The moral theory of deism was first articulated by Ralph Cudworth in his *Treatise Concerning Eternal and Immutable Morality* (1731).

In France the most famous deists were Jean Jacques ROUSSEAU and VOLTAIRE. In Germany deism was best represented in the biblical criticism of Hermann REIMARUS. America's best-known deists were Benjamin Franklin, Thomas Jefferson, George Washington, and Thomas Paine.

Dekker, Thomas A prolific English dramatist and pamphleteer, Thomas Dekker, b. *c.*1572, d. 1632, is best known for his comedy *The Shoemakers' Holiday* (1599), a good-humored portrayal of working life in Elizabethan London. His other works include the comic fantasy *Old Fortunatus* (1599), the realistic comedies *Westward Ho!* (1604) and *Northward Ho!* (1605; both with John Webster), and the two-part tragedy *The Honest Whore* (1604–05). He painted vivid pictures of London lowlife in such prose pamphlets as *The Gull's Hornbook,* describing the many ways a gentleman might be cheated, *The Bellman of London,* and *Lanthorne and Candlelight* (all 1608).

Delacroix, Eugène [duh-lah-kwah'] Ferdinand Victor Eugène Delacroix, b. Apr. 26, 1798, d. Aug. 13, 1863, was the leading exponent of romantic painting in France (see ROMANTICISM). Characteristic of Delacroix's pictures is unresolved tension and a romantic obsession with human mortality. *Greece Dying on the Ruins of Missolonghi* (1827; Musée des Beaux-Arts, Bordeaux), for example, commemorated the defeat of the Greek nationalists gathered there around Lord Byron in the early 1820s. Delacroix saw in the Greek struggle for independence against the Turks an affirmation of the ideal of liberty. In the painting Greece is personified as a young woman; the blood-spattered ruins on which she stands indicate defeat, and the greenish tint on the woman's breast, suggesting imminent death, symbolizes the defeat of a noble cause. The painting in many respects prefigures *Liberty Leading the People* (1830), in which the heroine is now the triumphant figure of liberty.


In Liberty Leading the People *(1830) the French romantic painter Eugène Delacroix transformed a violent political theme into a sensual reality. The woman, personifying Liberty, commemorates the July Revolution of 1830. (Louvre, Paris.)*

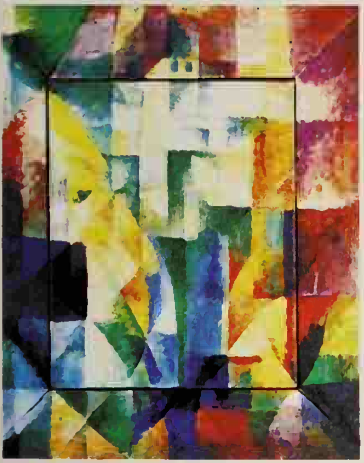
In 1832, Delacroix accompanied a French embassy to the sultan of Morocco. While at Tangiers he filled notebooks with drawings of local details for the paintings with Oriental subjects he would introduce into French art. In *Lion Hunt* (1861; Art Institute of Chicago), a Rubenesque picture filled with men, horses, and wild animals, such details as turbans and wild, non-European expressions are fused by the unreal color into an imaginative vision.

Literature was another powerful stimulus to Delacroix's imagination. The theme of Hamlet especially appealed to him because Shakespeare's hero was also tortured by the uncertainty of existence. In *Hamlet and Horatio in the Graveyard* (1859; Louvre, Paris) the figures appear amid reminders of human death. The ground slopes away under a sky filled with blood-red clouds. Painted with tenuous brushstrokes, the figures' surroundings seem to share their restlessness, and a fantasylike atmosphere pervades the scene.

Delacroix's career was studded with honors. He was awarded (1831) the medal of the Legion of Honor and was commissioned to decorate the Library of the Senate in the Luxembourg Palace and the Library of the Chamber of Deputies in the Bourbon Palace (both completed 1847). He was elected to the Institut de France in 1857.

Delany, Martin R. [duh-layn'-ee] Acknowledged as the founder of black nationalism in the United States, Martin Robinson Delany, b. Charlestown, Va., May 6, 1812, d. Jan. 24, 1885, was the son of free blacks. He studied medicine at Harvard, became a doctor, and then, turning to politics, advocated founding a new black nation on the east coast of Africa. Development of the project was halted by the Civil War. Delany was one of 75 black officers in the Union army, and after the war he worked for 3 years in the Freedmen's Bureau. He subsequently became active in South Carolina politics.

Delaunay, Robert [duh-loh-nay'] The Frenchman Robert Delaunay, b. Apr. 12, 1885, d. Oct. 25, 1941, was the founder of Orphism, a variant of CUBISM sometimes called orphic-cubism, and a pioneer of nonrepresentational painting in France. In his early works, such as *Eiffel Tower* (1909; Guggenheim Museum, New York City), Delaunay employed the faceted and geometrical forms of Picasso's and Braque's early cubism. By 1911, however, Delaunay, with his wife, the Russian artist Sonia Terk, had abandoned the monochromaticism of strict cubism and began to experiment with brilliant color planes and circular forms. Delaunay believed that recession, movement in space, and planar progression could be created exclusively through the use of color contrasts. *Simultanisme* was the term he used to refer to the dynamic, nonsequential effect of two or more colors perceived simultaneously; the poet and critic Guillaume Apollinaire called his style *Orphism.* In 1912, Delaunay produced some of his most memorable works exemplifying these theories, including *Circular Forms, Sun and Moon* (1912; Stedelijk Museum, Amsterdam).



In Robert Delaunay's Simultaneous Windows *(1911), planes of contrasting colors are juxtaposed in a cubist structure. This work exemplifies Orphism, which was concerned with the dynamic effects of color relationships. (Kunsthalle, Hamburg.)*

Delaware One of the Mid-Atlantic states, Delaware is flanked by Delaware Bay, the Delaware River, and the Atlantic Ocean on the east; Maryland to the south and west; and Pennsylvania to the north. In 1609, Henry Hudson became the first European to explore the area, and in 1638 the first permanent settlement was established by Swedes. The state's name is derived from that of Thomas West, Baron De La Warr, the first governor of Virginia, who served from 1609 to 1618. During most of its history, Delaware has combined elements of the urban, industrial north and of the more rural, agricultural south. Although larger only than Rhode Island, today its importance as an industrial state far exceeds its size. For more than 150 years the DU PONT family has played a major role in Delaware's economy and politics.

Land and Resources

With the exception of a small area of rolling hills in the extreme north, Delaware consists of a low, gently undulating plain that slopes down to the Atlantic Ocean. Maximum elevations reach 135 m (443 ft) in the hills. The lowland belongs to the Atlantic coastal plain and the upland to the PIEDMONT region. The northeast to southwest-trending FALL LINE separates these two regions. Most of Delaware is characterized by two types of ultisols (soils built on clay accumulation): humults, with a high organic carbon content, found in northern and central sections; and aquults, with a higher clay content, found in coastal and southern sections.

Rivers and Lakes. Most of the rivers of Delaware, including the Christina and its tributary Brandywine Creek, are short and flow eastward; exceptions are the Nanticoke and Pomocoke in the south, which empty southwestward into CHESAPEAKE BAY. Salt and freshwater marshlands are prevalent in the center of the state, along Delaware Bay. Pocomoke Swamp, a cypress swamp, is located in southern Delaware. Groundwater is ample because of the presence of permeable marine deposits atop crystalline bedrock.

Climate. Delaware's climate is humid-continental, with long summers and relatively mild winters. Wilmington has a mean temperature of 0° C (32° F) in January and 24° C (75° F) in July. Although Delaware lies in the storm track of Gulf of Mexico disturbances and continental weather systems from the west, the Atlantic Ocean and Chesapeake Bay exert a moderating influence. Annual precipitation averages 1,105 mm (44 in).

Vegetation and Animal Life. Oak, beech, walnut, maple, and dogwood are prevalent in northern Delaware. In the south, loblolly and Virginia pines are mixed with sweet and black gums, oaks, maples, yellow poplars, and hollies. Forest covers 1,555 km^2 (600 mi^2), nearly all of which is of commercial quality. Deer and small game—raccoon, opposum, fox, and muskrat—abound. The state is on the Atlantic migratory bird flyway, and the marshy Delaware Bay shore is a refuge for both migrating and local birds.

Natural Resources. Mineral resources are located in the north, with kaolin the most significant, followed by construction granite, gravels, and clay. No hydroelectric power has been developed. The Coastal Zone Act, protecting the coastal wetlands, was passed in 1971; regarded as a major step in balancing development with the natural environment, it has nevertheless been challenged by economic interests.

People

As a megalopolitan state, Delaware has a population den-

AT A GLANCE

DELAWARE

Land: Area: 5,297 km^2 (2,045mi^2); rank: 49th. Capital: Dover (1990 pop., 27,630). Largest city: Wilmington (1990 pop., 71,529). Counties: 3. Elevations: highest—135 m (442 ft), in New Castle County; lowest—sea level, at the Atlantic coast.

People: Population (1990 est.): 666,696; rank: 46th; density: 125.9 persons per km^2 (326.0 per mi^2). Distribution (1988 est.): 65.9% metropolitan, 34.1% nonmetropolitan. Average annual change (1980–90): +1.25%.

Government (1991): Governor: Michael N. Castle, Republican. U.S. Congress: Senate—1 Democrat, 1 Republican; House—1 Democrat. Electoral college votes: 3. State legislature: 21 senators, 41 representatives.

Economy: State personal income (1988): $11.7 billion; rank: 44th. Median family income (1979): $20,817; rank: 17th. Agriculture: income (1988)—$592 million. Fishing: value (1988)—$3 million. Forestry: sawtimber volume (1987)—1.8 billion board feet. Mining: value (1987, partial data only)—$6 million. Manufacturing: value added (1987)—$3.9 billion. Services: value (1987)—$2.8 billion.

Miscellany: Statehood: Dec. 7, 1787; the 1st state. Nicknames: The First State, The Diamond State; tree: American holly; motto: "Liberty and Independence"; song: "Our Delaware."

Blue hen chicken

Peach blossom

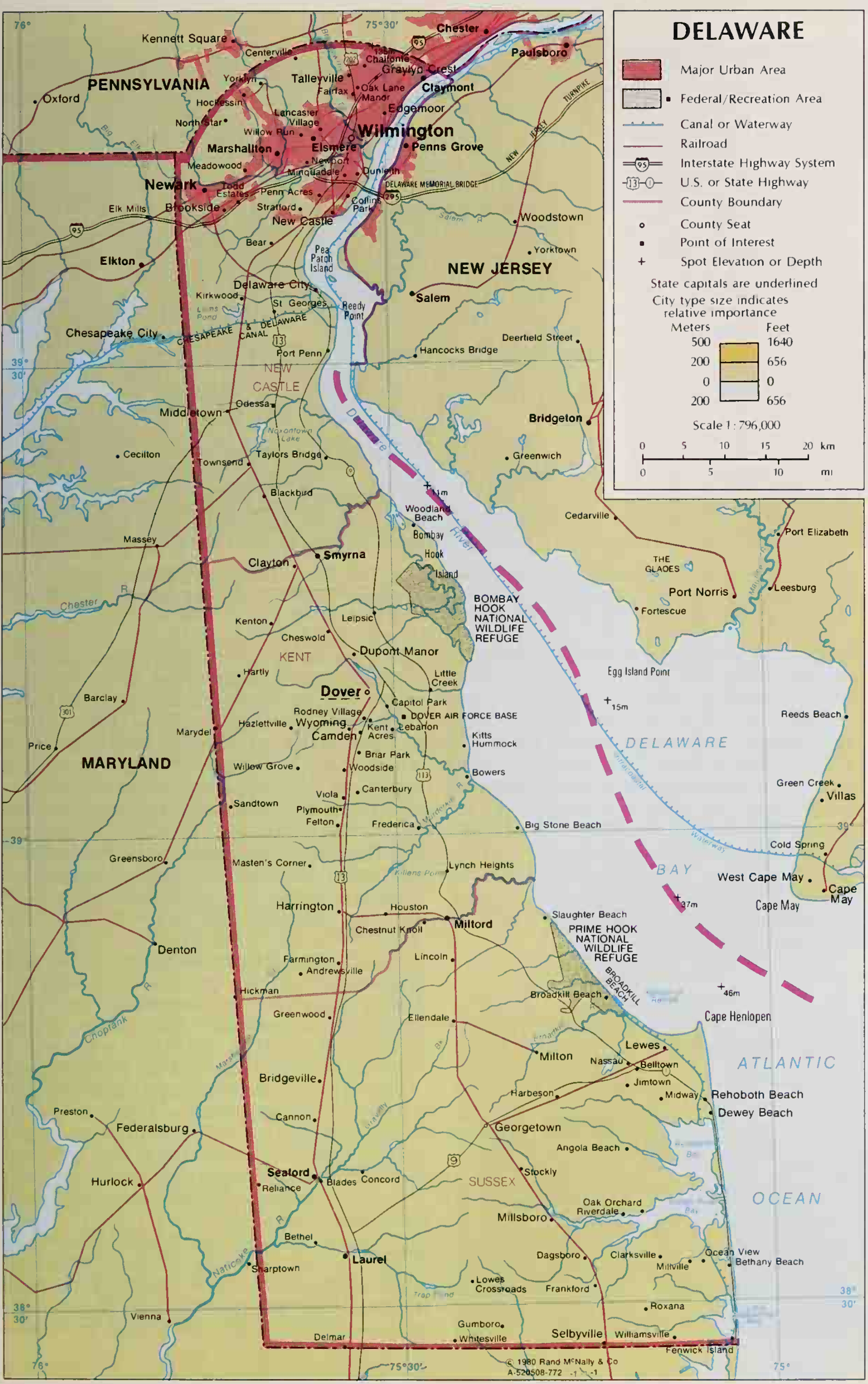
sity of 126 persons per km^2 (327 per mi^2). In 1988, an estimated 66% of the population lived in metropolitan areas. A decline in WILMINGTON's population from 110,356 in 1950 to 71,529 in 1990 reflects a steady trend toward suburbanization. Delaware's annual growth rate from 1980 to 1990 was 1.25%. In 1990 the population was about 80% white and 17% African American. The foreign-born come mainly from the United Kingdom, Italy, and Germany. Methodists, Presbyterians, Roman Catholics, and Episcopalians are the principal religious groups.

Education. A public-education system was established largely through the efforts of Willard Hall (1780–1875) in 1829, but funding and teaching were uneven, and blacks were excluded. In 1907 compulsory education was instituted. Lobbying, financial pressure, and outright financing by Pierre du Pont during the 1920s finally led to the creation of an administrative and taxation system capable of supporting modern educational facilities. In 1954 schools were desegregated, and in 1978 court-ordered busing mixed white suburban schools with those of Wilmington, which were predominantly black. Institutions of higher learning are the University of Delaware at NEWARK, which evolved from an academy in existence in 1743, and Delaware State College.

Cultural Institutions. Cultural institutions, primarily museums, are concentrated in the north, and are mainly the legacy of wealthy hobbyists. The Hagley Museum, site of the first du Pont factory near Wilmington, has early American industrial history collections, and Winterthur Museum, also near Wilmington, has 100 rooms of early American furniture from the du Pont collection. Other cultural centers include the Delaware Art Museum in Wilmington, a museum of natural history in Greenville, and the state history museum in Dover.

Historical Sites and Recreation. Among the state's historical sites are the colonial capital, New Castle, with a historic district containing many 17th- and 18th-century buildings; "Old Swedes" church (used since 1699) in Wilmington; Fort Delaware (completed 1860) on Pea Patch Island; Dickinson House (built 1740) near Dover; and the State House (built 1792), in DOVER, one of America's oldest state capitals. The Bombay Hook, Prime Hook, and Chesapeake and Delaware canal national wildlife refuges are in Delaware; Delaware Seashore, Cape Henlopen, and Brandywine Springs are the principal state parks. Rehoboth Beach is a well-known resort.

Communications. Delaware has three daily newspapers. Communications facilities such as newspapers and broadcasting are of local significance only, except for


DELAWARE
Major Urban Area
Federal/Recreation Area
Canal or Waterway
Railroad
Interstate Highway System
U.S. or State Highway
County Boundary
County Seat
Point of Interest
Spot Elevation or Depth
State capitals are underlined
City type size indicates relative importance
Meters
Feet
500
1640
200
656
0
0
200
656
Scale 1 : 796,000
0 5 10 15 20 km
0 5 10 mi
76°
75°30′
39° 30′
39°
38° 30′
75°
PENNSYLVANIA
NEW JERSEY
MARYLAND
NEW CASTLE
KENT
SUSSEX
Kennett Square
Centerville
Oxford
Yorklyn
Talleyville
Chester
Paulsboro
Chalfonte
Graylyn Crest
Fairfax
Oak Lane Manor
Claymont
Hockessin
Lancaster Village
Edgemoor
North Star
Willow Run
Wilmington
Marshallton
Elsmere
Penns Grove
Meadowood
Newport
Minquadale
Dunleith
DELAWARE MEMORIAL BRIDGE
Newark
Todd Estates
Penn Acres
Collins Park
Elk Mills
Brookside
Stratford
New Castle
Woodstown
Bear
Pea Patch Island
Yorktown
Elkton
Delaware City
Kirkwood
St Georges
Reedy Point
Salem
Chesapeake City
CHESAPEAKE & DELAWARE CANAL
Port Penn
Deerfield Street
Hancocks Bridge
Odessa
Middletown
Noxontown Lake
Bridgeton
Cecilton
Townsend
Taylors Bridge
Greenwich
Blackbird
Woodland Beach
Bombay Hook Island
Cedarville
Port Elizabeth
Massey
Smyrna
Clayton
THE GLADES
Port Norris
Leesburg
BOMBAY HOOK NATIONAL WILDLIFE REFUGE
Fortescue
Chester R
Kenton
Leipsic
Cheswold
Dupont Manor
Egg Island Point
Hartly
Little Creek
Dover
Capitol Park
DOVER AIR FORCE BASE
Barclay
Rodney Village
Hazlettville
Wyoming
Kent Acres
Lebanon
Camden
Marydel
Kitts Hummock
Reeds Beach
Price
Briar Park
Woodside
Willow Grove
Bowers
DELAWARE
Green Creek
Villas
Canterbury
Viola
Sandtown
Plymouth
Felton
Frederica
Big Stone Beach
Greensboro
Cold Spring
Masten's Corner
Lynch Heights
Killens Pond
BAY
West Cape May
Cape May
Harrington
Houston
Milford
Slaughter Beach
Chestnut Knoll
PRIME HOOK NATIONAL WILDLIFE REFUGE
Denton
Lincoln
Farmington
Andrewsville
Hickman
BROADKILL BEACH
Broadkill Beach
Cape Henlopen
Greenwood
Ellendale
Choptank
Lewes
Milton
Nassau
Belltown
ATLANTIC
Bridgeville
Jimtown
Harbeson
Midway
Rehoboth Beach
Preston
Dewey Beach
Cannon
Federalsburg
Georgetown
Angola Beach
Stockly
Seaford
Blades
Concord
Hurlock
Reliance
OCEAN
Oak Orchard
Riverdale
Millsboro
Bethel
Dagsboro
Clarksville
Ocean View
Millville
Bethany Beach
Laurel
Sharptown
Nanticoke
Lowes Crossroads
Frankford
Roxana
Vienna
Gumboro
Selbyville
Williamsville
Delmar
Whitesville
Fenwick Island
Delaware River
Intracoastal Waterway
11m
15m
37m
46m
95
295
13
113
9
301
NEW JERSEY TURNPIKE
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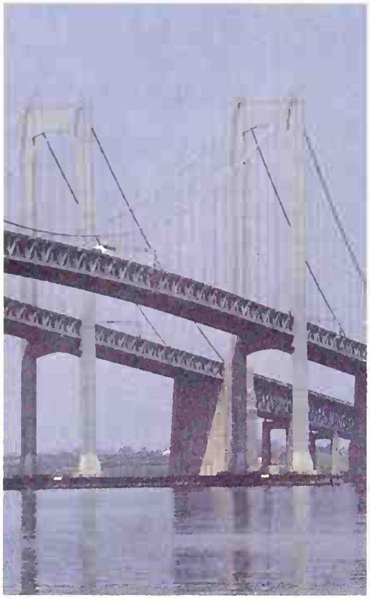


(Left) *The Delaware Memorial Bridge, one of the world's longest suspension bridges, with a main span of 665 m (2,180 ft), links Delaware and New Jersey.* (Right) *The beaches of Cape Henlopen State Park, at the mouth of Delaware Bay, are visited by thousands of tourists annually. A breakwater has been constructed along the cape to protect Wilmington-bound ships from Atlantic storms.*

public television, which serves the Philadelphia region from Wilmington.

Economic Activity

Agriculture, Forestry, and Fishing. More than 50% of Delaware's farm income is derived from the production of broiler chickens; the remainder comes from a variety of market-oriented items, including milk, vegetables, and soybeans. Fishing is declining, but crabs, shad, cod, oysters, and clams are caught. Forestry is a minor industry, with pulp, sawlogs, and poles the principal products.

Despite Delaware's industrial economy and the small percentage of agricultural workers in the labor force, the net income per farm exceeds the national average.

Manufacturing, Industry, and Transportation. Since the colonial period, Wilmington and northern Delaware have been the state's main industrial center, although some industry has spread downstate. Delaware's leading industries include chemicals, food processing, primary metals, machinery, printing and publishing, leather goods, fabricated metals, transportation equipment, and textiles.

The Chesapeake and Delaware canal, linking Delaware and Chesapeake bays, as well as the Delaware River and the port of Wilmington, accommodate most oceangoing vessels.

Government

Delaware is governed by the constitution of 1897, which was created by a constitutional convention but not ratified by the people. The governor is elected for 4 years and may serve only two terms. The governor has veto power, although a three-fifths vote in each house will override it. The legislature consists of a 21-member Senate and a 41-member House of Representatives; senators serve 4-year terms and representatives 2-year terms.

The judiciary consists of a supreme court, superior courts, courts of common pleas, family courts for juveniles, and a court of chancery for corporate matters. The Republican party has somewhat dominated the state's politics in recent years.

History

The Lenni-Lenape, or Delaware, were the original inhabitants. In 1631 the first European settlement was attempted when the DUTCH WEST INDIA COMPANY established a to-

Rodney Square in Wilmington contains a statue (lower right) *of Caesar Rodney, the colonial legislator who cast Delaware's deciding vote to endorse the Declaration of Independence. Wilmington is the largest city in Delaware.*

bacco-growing and whaling industry at Zwaanendael (present-day Lewes). The settlement lasted only a year because of Indian attacks. In 1638, Swedish settlers established the first permanent settlement, Fort Christina (present-day Wilmington), as part of the colony of NEW SWEDEN.

In 1655 the colony was lost to the Dutch, who, in turn, surrendered it to the British in 1664. In 1682, Delaware came under the proprietorship of William PENN, but it was administered separately from Pennsylvania as a distinct entity called the "three counties of Delaware." Delaware became (1787) the first state to ratify the U.S. Constitution.

Geographically and historically, Delaware has a dual personality, which it acquired early and has never lost. New Castle County in the north, where Wilmington is located, grew in response to urban-industrial developments in nearby Philadelphia; Kent and Sussex counties to the south remained rural and culturally a part of the American South. As early as the 1730s Wilmington was a developing grain port and shipbuilding center at the confluence of the Christina and Delaware rivers. The Christina gave Wilmington access to its hinterland, and nearby Brandywine Creek provided excellent mill sites. Thus one of America's most intensive manufacturing districts came into being. In 1802 a French immigrant, Éleuthère Irénée du Pont de Nemours, established a powder mill near Wilmington, beginning Delaware's chemical industry.

By the mid-19th century the Delaware landscape had lost its frontier appearance. In New Castle County, industry had expanded from simple tanning, grain milling, and papermaking to sophisticated gunpowder and textile manufacturing, benefiting from improved turnpikes, the construction (1829) of the Chesapeake and Delaware canal, and the completion of the Philadelphia, Wilmington, and Baltimore Railroad. In 1856 the construction of a railroad extending the length of the state brought an agricultural boom to southern Delaware but did not change the rural character of the area.

Although a slave state, Delaware had fewer than 2,000 slaves and about 20,000 free African Americans in 1860. It was divided over the slavery issue during the Civil War; the majority, however, was moderate and supported the Union. Many soldiers from Delaware fought in the Union army. After the Civil War, African-American rights were vigorously opposed. In 1873, African Americans were effectively disenfranchised by poll taxes and corrupt politics. The poll tax was replaced (1897) by a literacy test.

Economic growth continued after the Civil War and was concentrated in the Wilmington area. It was aided by tax laws instituted in 1899, encouraging corporations to locate their headquarters in Wilmington. By 1920 the city contained almost half of Delaware's population.

Partly because of the conservative influence of southern Delaware, the state lagged behind many others in such areas as prison reform and social services. As a result of legislative conflict between northern and southern factions, state unemployment insurance was withdrawn (1934) at the height of the Great Depression. Legislative districts that had long benefited the rural south were not redrawn until the 1960s in favor of the more populous Wilmington suburbs. In 1968, when riots by unemployed African Americans broke out in Wilmington, the National Guard was called in. Present-day Delaware faces a problem common to much of the United States—suburban crowding as a result of rapid development. Economic growth in Delaware in the 1980s was fueled by the passage of laws favorable to banking and corporate interests, but as the state entered the 1990s the issue of economic growth at the expense of the environment was a continuing debate.

Delaware (Indian tribe) The Delaware, an Algonquian-speaking confederacy of North American Indian tribes, formerly inhabited present-day New Jersey and parts of adjacent New York, Pennsylvania, and Delaware. Named the Delaware by English settlers, they called themselves Lenni-Lenape. Their confederacy included three major tribes: the Munsee, Unalachtigo, and Unami.

Delaware lands were heavily colonized by 1682, the year of the Delaware's first formal council with Gov. William Penn. By 1720 the Five Nations IROQUOIS LEAGUE dominated much of their remaining homeland, and the Delaware began gradually migrating westward, ultimately establishing villages in eastern Ohio. They joined forces with their new allies, the Wyandot and Shawnee, and steadfastly resisted American expansion until the Treaty of Greenville in 1795, when they ceded their Ohio lands. Thereafter, the Delaware were widely dispersed, with bands in Ohio, Missouri, Arkansas, Texas, and Ontario. Many Delaware served as army scouts during the settlement of the Plains and the Northwest in the 19th century. The Delaware affiliated with bands in Ontario and Oklahoma numbered more than 11,000 in the late 1980s.

See also: DELAWARE PROPHET.

Delaware Prophet The Delaware Prophet was an 18th-century religious visionary and leader of the Delaware Indians in the Ohio Valley. About 1762 he began to preach his vision of a new way of life that would revitalize the Indians of interior North America and help them to resist the whites. His preachings centered on a nativistic revival of ancient Indian ways and the abandonment of firearms and other things of European origin.

Also known as the Imposter to English colonists (his real name is unknown), the Delaware Prophet founded one of numerous American Indian religious movements that sprang up during the 18th and 19th centuries. Perhaps his greatest influence was on the Ottawa tribal chief Pontiac, who heeded the Prophet's messages in planning his attack on English posts in the upper Great Lakes region in 1763. After the defeat of PONTIAC'S REBELLION in 1766, interest in the Delaware Prophet waned. In the early 19th century the SHAWNEE PROPHET preached a similar doctrine.

See also: DELAWARE (Indian tribe).

Delaware River The Delaware River rises in the Catskill Mountains of southeastern New York and flows for about 650 km (400 mi) southeastward, mostly along Pennsylvania's eastern border, into Delaware Bay, an inlet of the Atlantic Ocean separating Delaware from New Jersey. The river drains an area of about 31,900 km^2 (12,300 mi^2). Below Trenton, N.J., the head of navigation, are Philadelphia and Wilmington, Del. Flowing through a densely settled region for most of its course, the Delaware is an important commercial waterway, and its lower reaches are lined with oil refineries, shipyards, chemical plants, and other heavy industries. The scenic upper reaches and headstreams are an important source of water for the river's downstream cities and New York City.

Delaware Water Gap The Delaware Water Gap is a deep, narrow gorge where the Delaware River flows southward through the Kittatinny Mountains east of Stroudsburg, Pa. The gap is about 4 km (2.5 mi) long, with walls rising about 425 m (1,400 ft) on each side. It was originally carved by a north-flowing river but is now used by the south-flowing Delaware. Mount Tammany is on the New Jersey side of the gap, and Mount Minsi is on the Pennsylvania side. Scenic rail and auto routes follow the path of the river through the gorge.

Delcassé, Théophile [del-kah-say'] Théophile Delcassé, b. Mar. 1, 1852, d. Feb. 22, 1923, was a French foreign minister who shaped the French alliance systems before WORLD WAR I. He entered the Chamber of Deputies in 1889 and served as minister of colonies (1894–95) and then foreign minister (1898–1905, 1914–15). Despite the Franco-British tension caused by the FASHODA INCIDENT (1898), Delcassé overcame his anti-British feelings in the face of the threat posed by Germany. He worked to form the Anglo-French Entente Cordiale of 1904 and thus laid the groundwork for the TRIPLE ENTENTE (1907), which aligned France, Britain, and Russia. German pressure during the Moroccan Crisis of 1905 forced him out of office. Delcassé was later minister of the navy (1911–13) and ambassador to Russia (1913–14) before returning as foreign minister at the outbreak of World War I. He helped negotiate the Treaty of London (April 1915) that brought Italy into the war on the Allied side.

Delft Delft is a city in the southwestern Netherlands, about 8 km (5 mi) south of The Hague. It is located on the canalized Schie River, and its population is 87,440 (1986 est.). The city has crisscrossing canals; the old inner city is surrounded by a moat. Delft is the home of De Porceleyne Fles (founded 1653), the company that manufactures the famous hand-painted blue-and-white earthenware called delftware. Other manufactures include pharmaceuticals and machinery.

Delft was founded in 1075 and chartered in 1246. William the Silent had his headquarters at the 15th-century Prinsenhof, now a museum. His tomb, along with those of other Dutch royalty, is in the Nieuwe Kerk ("New Church"). The Paul Tetar van Elven Museum contains a 19th-century painter's home and a 17th-century studio, and the Huis van Meerten Museum features a massive collection of delftware. The 15th-century Gothic Nieuwe Kerk is on the town square. The Oude Kerk ("Old Church") is a 13th-century Gothic structure. Delft is the home of a technical university, Technische Hogeschool te Delft (1905).

delftware Delftware is a kind of tin-glazed earthenware, or faïence, produced since the 17th century, primarily in the town of Delft in the Netherlands. The most famous type of delftware is characterized by blue-and-white decoration, the forms and motifs of which were inspired by Chinese and Japanese models. Another kind of blue-and-white delftware is decorated with European themes, landscapes, and figures in a style inspired by 17th-century Dutch painting. The term *delftware* also refers to earthenware of a similar kind made in England during the 17th and 18th centuries.

Delftware, a variety of tin-glazed earthenware often adorned with motifs from Chinese porcelains, takes its name from the Dutch city of Delft, where it was popularized between the 17th and 19th centuries.

Delhi see NEW DELHI

Delhi Sultanate [del'-ee suhl'-tin-ayt] The Delhi Sultanate was a Muslim kingdom in northern and northwestern India ruled by a succession of Afghans from the late 12th century to the 16th. Ruling from Delhi, this dynasty was essentially an unassimilated military occupation force.

This occupation began with the invasion (1175–1206) of northern India by Muhammad of Ghor. After Muhammad's assassination in 1206, his general, Qutb ud-Din, became the first sultan of Delhi. Within a century most of the Indian subcontinent came under the influence of the sultans, who were forced to concentrate their power in the north to counter the Mongol threat. Probably the most powerful of these Afghan rulers was Ala ud-Din (r. 1296–1316), who conquered parts of southern India. In 1398 the Mongols succeeded in breaking through the sultans' defenses when TIMUR sacked Delhi and effectively destroyed the sultanate. The sultans continued to rule a small territory around Delhi until conquered by BABUR in 1526.

Delian League [del'-ee-uhn] The Delian League was established in 478 BC under the leadership of ATHENS to preserve the freedom of Greek states newly liberated from Persia in the aftermath of the PERSIAN WAR of 480–479. This new alliance also contemplated carrying the war against Persia into its own territories. The league held meetings on the island of DELOS, sacred to Apollo, and stored its common treasury there. The Athenians dictated what the assessments were to be; some states, like Athens, contributed ships and men instead of money.

The league was successful in driving the Persians from the Aegean Sea, but its nature gradually altered. Originally established on the basis of equality among members, the preponderant power of Athens soon made the league subservient to Athenian interests. When the occasion demanded, Athens used force to keep the allies in line. By 454, when the treasury was transferred to Athens, the league clearly had been transformed into the Athenian empire.

See also: GREECE, ANCIENT.

Delibes, Léo [duh-leeb'] Léo Delibes, b. Feb. 21, 1836, d. Jan. 16, 1891, was a French composer best known for his ballet music. Delibes produced mostly comic operas and operettas with moderate success until 1866, when he composed, in collaboration with Ludwig Minkus, the ballet *La Source*, which revealed his talent for dance music. His first complete ballet, the comedy *Coppélia* (1870), remains a standard work in the ballet repertoire. His later, serious dramatic works, including the opera *Lakme* (1883), were less successful.

Delilah In the Bible, Delilah was the woman who betrayed SAMSON. After discovering that Samson's strength was in his hair, Delilah had it shaved off. The Philistines then imprisoned him (Judges 16).

delirium Delirium is a condition of mental confusion typified by motor excitement, confused and unconnected ideas, and, frequently, delusions. It sometimes accompanies high fever, and it may also result from malnutrition. Delirium tremens (trembling delirium, or the DTs) can occur after excessive alcohol abuse, or among people withdrawing from the use of certain drugs. In its most acute form it is characterized by vivid and often terrifying hallucinations and by sleeplessness, rapid heart rate, seizures, and tremors of the hands, lips, and tongue. The use of tranquilizers alleviates the fear and trembling that accompany delirium tremens, which, if left untreated, may cause death from seizure, heart failure, or other complications.

delirium tremens see ALCOHOL CONSUMPTION

Delius, Frederick [deel'-eeuhs] Frederick Delius, b. Jan. 29, 1862, d. June 10, 1934, was an English-born composer of German descent whose descriptive orchestral pieces are thought by many to convey the essence of the English countryside. Delius, however, felt no great enthusiasm for the country of his birth and emigrated from England before the age of 20. After a brief period as an orange planter in Florida, he returned to Europe to study at the Leipzig Conservatory. Successful performances of several of Delius's works took place in Germany between 1897 and 1907. The large choral work *A Mass of Life* was first performed (1909) in London under Sir Thomas Beecham, a champion of Delius's music.

Scandinavian folk songs, French impressionism, and American Negro spirituals all contributed to Delius's personal style. Delius best expressed his musical personality in small-scale pieces such as *A Song of the High Hills*, for orchestra and wordless chorus, and the purely orchestral

The music of the British-born composer Frederick Delius is highly individualistic. Influenced by diverse sources, from Scandinavian music to American folk music, Delius composed many small orchestral pieces, songs, and operas that are not easily categorized.

In a Summer Garden, On Hearing the First Cuckoo in Spring, Summer Night on the River, and *North Country Sketches*.

della Francesca, Piero see Piero della Francesca

della Robbia (family) [del-lah rohb'-byah] The reputation of the della Robbia family rests on the works of the great Florentine Renaissance sculptor **Luca della Robbia**, b. 1399 or 1400, d. Feb. 23, 1482, the founder of a famous enameled-terra-cotta workshop. Luca matriculated (1432) in the guild of workers in stone and wood and was already an established artist when he produced his first major work, the *Cantoria* or *Singing Gallery* (1431–38; Cathedral of Florence), a series of relief panels. The individuality of Luca's style is shown in the lively expression of the performing musicians in combination with the classical serenity with which the reliefs are imbued. A static purity of form is also apparent in Luca's *Federighi Tomb* (1454–57; Santa Trinità, Florence) and remained an aspect of his style until late in life. It is evident in his bronze doors (1464–69) for the New Sacristy of the Cathedral of Florence.

Luca's enameled terra-cotta was originally used as a coloristic accessory to marble sculpture. *Resurrection* (1442–45) and *Ascension* (1446–51), his enameled terra-cottas above the portals of the Cathedral of Florence, serve as focal points of color in high, poorly lighted areas where marble would have been ineffective. The medium became popular, and after Luca died his workshop produced increasing numbers of altarpieces and devotional madonnas under his nephew **Andrea della Robbia**, 1435–1525, and Andrea's sons, **Giovanni**, 1469–1539, and **Girolamo**, 1488–1566. None of these, however, possessed Luca's originality, although his style was ably imitated by Andrea, as in *St. Francis and St. Dominic* (*c.*1493; Hospital of St. Paul, Florence). Giovanni and Girolamo, however, exploited the pictorial elements of terra-cotta at the expense of good design.

This detail of Singing Angels *(1431–38) is from one of ten marble reliefs carved by Luca della Robbia for the* Cantoria *(Singing Gallery) in Florence Cathedral. (Museo dell'Opera del Duomo, Florence.)*

Dello Joio, Norman [del'-loh joy'-oh] Norman Dello Joio, b. New York City, Jan. 24, 1913, is a composer who in his music has fused 17th-century forms (occasionally Gregorian chant) with 20th-century rhythmic and harmonic styles. He first attracted notice in 1942 with his *Magnificat*. The orchestral *Meditations on Ecclesiastes* won the Pulitzer Prize for music in 1957. Later works include *Blood Moon* (1961), an opera, and *Evocations* (1970), for chorus and orchestra.

Delmarva Peninsula [del-mar'-vuh] The Delmarva Peninsula, about 290 km (180 mi) long and a maximum of 115 km (71 mi) wide, comprises Delaware and the eastern shores of Maryland and Virginia. Its name is derived from the first initials of the names of the three states. The peninsula is bounded on the west by the Chesapeake Bay and on the east by the Delaware River, Delaware Bay, and the Atlantic Ocean. Cape Charles is at its southern tip.

Delorme, Philibert [de-lawrm'] Philibert Delorme (or de l'Orme), b. *c.*1510, d. Jan. 8, 1570, was an important architect of the French Renaissance. His work combined the new style of the Italian High Renaissance with elements drawn from traditional French architecture. Delorme's first major work in France was the Château of St. Maur des-Fosses (1541–47), near Paris. In 1548 he became superintendent of buildings under Henry II, for whom he built (1557) the Château-Neuf at St. Germain. Other notable commissions include the Château d'Anet (1547–52), the bridge at the Château de Chenonceaux (1556–59), and the Tuileries (1564) in Paris.

Delors, Jacques [duh-lawr'] Jacques Lucien Jean Delors, b. July 20, 1925, is president of the European Commission (the executive organ of the European Economic Community, or EEC) and chief architect of the plan to eliminate the EEC's internal trade barriers by 1992. A French economist and former economic advisor to the French government, Delors became EEC president in 1985 and began a second 4-year term in 1989. With Britain's Lord Cockfield, he prepared the Single European Act (1986), which charted the course for a tariff-free European trade zone. Delors has also pushed for the creation of a unified EEC monetary system and the adoption of unified economic and social policies.

Delos [dee'-laws] Delos, a Greek island of granite formation in the Aegean Sea, is one of the smallest of the Cyclades, with a land area of 3.4 km^2 (1.3 mi^2) and a population of 16 (1981). According to legend, the island floated until Zeus anchored it so that Leto could give birth to the twins Apollo and Artemis.

Objects dating from the early Bronze Age indicate that Delos has been inhabited since the 3d millennium BC. About the 10th century BC it was colonized by Ionians, who developed the cult of Apollo. Delos came under Athenian domination and served (478–54) as the treasury of the Delian League. A major commercial center, it was independent from 322 to 166 BC, when it came under Roman rule. Excavations since 1873 have uncovered ruins such as sanctuaries, a theater, an agora, a stadium, and homes with mosaic courtyards.

Delphi [del'-fy] Delphi, located in Phocis, Greece, on the lower southern slopes of Mount Parnassus near the Gulf of Corinth, was an ancient Greek city considered to be sacred to Apollo, the god of prophecy and patron of philosophy and the arts. His famous temple and prophetic shrine were there. The temple within the surrounding sanctuary was the home of the famous Delphic oracle. Consulted by Oedipus, Socrates, and other well-known ancient figures, it gave its messages in such ambiguous ways that it could seldom be proven wrong.

Delphi was also sacred to Dionysus, the god associated with wine, fertility, and orgiastic dance, and to the nine muses, patron goddesses of music, literature, and history. For the Greeks, therefore, at Delphi the rational creativity of Apollo and the irrational creativity of Dionysus merged. Every four years the Pythian Games were held in Delphi. During the 1890s and the early 20th century, archaeologists unearthed much of the gymnasium and stadium where these games were held. The sanctuary of Apollo has also been excavated, and many notable works of sculpture found.

delphinium [del-fin'-ee-uhm] *Delphinium* is a genus of about 300 species of perennial to annual herbs native to the Northern Hemisphere. Members of the crowfoot family, Ranunculaceae, the plants are also called larkspurs, but the garden annual larkspur is placed in a separate genus, *Consolida*. Some delphiniums reach heights of 2.5 m (8 ft) or more; others are low-lying. The leaves are cleft; the flowers, usually blue to white, are red or yellow in some species. Growing on spikes, they have five asymmetrical sepals and four to six spurred petals. Wild delphiniums, which frequently grow in pasturelands, are palatable to grazing animals, but many species contain poisonous alkaloids that cause loss of appetite and a staggering gait. In severe cases bloating can occur, and medication becomes essential.

The stately candle delphinium grows in tall spikes that tower above other garden plants. The blue, petallike sepals of each flower contrast with the small, purplish to lavender or yellow petals, sometimes called the "bee," at the center of the blossom.

Delta Delta rockets are a family of vehicles by which a wide variety of satellites have been launched as part of U.S. and international space programs. NASA placed the original contract with the Douglas Aircraft Company in April 1959. The early three-stage vehicle had an overall length of 26.8 m (88 ft), and the rocket's lift-off weight was 51,480 kg (113,500 lb). The modified Thor first stage had a thrust of about 756,000 newtons (77,100 kg/170,000 lb). Many modifications have been made since the first Deltas, including the nine strap-on boosters now used on Delta 2.

Delta Plan The Delta Plan, an immense flood-control project (see floods and flood control) along the southwest coast of the Netherlands, links various islands in the deltas of the Rhine, Maas, and Scheldt rivers and was designed not only to keep out the sea but also to control the salinity of the region's water. The plan did not seal the New Waterway and the Western Scheldt (which provide access to Rotterdam and to Antwerp, Belgium), because of their heavy volume of shipping traffic.

In 1953 severe storms caused the overtopping and breaching of many polder dikes, resulting in major flooding and loss of life. To reduce the danger of similar disasters, the Dutch parliament approved the Delta Plan in 1958. The project created a network of tidal-salt, stagnant-salt, and freshwater areas. Unique lock systems prevent the mixing of salt water and fresh water; excess fresh water is discharged into the sea at low tide by sluices. Dams have created gigantic reservoirs of fresh water to serve industrial and agricultural needs and to reduce saltwater infiltration of agricultural soils. The dams also protect many existing polder dikes from damage by the sea.

By 1972 most of the project, including the gigantic Haringvliet and Brouwers dams, had been completed; it was not until 1986, however, that a movable storm-surge barrier through which tides would normally flow freely was built across the mouth of the Eastern Scheldt and became fully operational. It extends 9 km (5.6 mi) from shore to shore between two artificial islands and consists of 62 massive steel gates hung between 65 twelve-story concrete pillars, each weighing up to 17,500 metric tons (19,290 U.S. tons).

delta wave see brain

Deluge [del'-yooj] In the Bible, the Deluge was a great flood that covered the Earth at the time of NOAH. According to Genesis 6–9, every living thing was destroyed except for the creatures aboard the ark.

Stories about a similar deluge are known in many parts of the world. No evidence exists, however, for a universal flood. The biblical flood story is structurally similar to the Mesopotamian accounts: the Sumerian version, Akkadian versions in the Atra-hasis and GILGAMESH epics, and the late Greek version by Berossus. Many features of the biblical story can be explained only by the earlier Mesopotamian versions. The biblical writers, however, presented the Deluge as God's punishment for human sin.

delusion see PARANOIA; SCHIZOPHRENIA

Delvaux, Paul [del-voh'] Paul Delvaux, b. Sept. 23, 1897, is a Belgian surrealist painter. After having painted as a postimpressionist, then as an expressionist, he painted his first surrealist works about 1935, under the influence of another Belgian, René MAGRITTE. Almost all of Delvaux's works from that date portray nude or seminude women, usually in a classical piazza or in the streets of a provincial town. Sometimes the painting includes a fully clothed man looking at the nude women, who ignore him. Thus Delvaux's themes include sexual voyeurism and narcissism.

Delvaux's paintings belong to the realist branch of SURREALISM, which had its beginnings in the works of Giorgio de CHIRICO. He uses de Chirico's deep-perspective space as a setting for the incongruous scene of a man raising his hat to a partially draped woman in *The Encounter* (1938; Museum of Modern Art, New York City). Delvaux's imagery here—as distinct from the setting—is derived from Magritte but is less startling. Delvaux's work was exhibited with that of the surrealists, although he never formally became a member of the group.

In his painting Hands *(1941), an example of naturalistic surrealism, the Belgian artist Paul Delvaux has created a strangely disconcerting psychological world of dreams, using a precise, realistic technique and perspective. (Collection of Claude Spark, Choisel.)*

demand deposit In banking, the term *demand deposit* refers to money that may be withdrawn on demand or against which checks may be written. In countries with developed BANKING SYSTEMS, checks have become the most common means of transferring funds from one party to another. Demand deposits are also major components of bank holdings.

Demavend, Mount see ELBURZ MOUNTAINS

dementia [dih-men'-shuh] Dementia is a severe and irreversible deterioration of mental abilities. Among the many different forms of dementia are those caused by injury, schizophrenia, and senility and by various disorders of the brain. Dementia praecox is an obsolete term for schizophrenia.

Demerol [dem'-ur-awl] Demerol, the trade name for meperidine, is a synthetic drug similar to morphine and used as an analgesic. It is administered orally or injected outside the intestines. Demerol acts more rapidly but is of shorter duration than morphine; it is also a narcotic and is habit-forming. Possible adverse reactions include coma, cyanosis, decreased respiration, and lowered blood pressure.

Demerol reacts adversely when combined with drugs such as monoamine oxidase (MAO) inhibitors, causing convulsions, coma, and possibly death. Caution is advised, especially when Demerol is administered to asthma and shock patients and to pregnant women.

Demeter [dih-mee'-tur] In Greek mythology, Demeter was the goddess of agriculture. She was the daughter of Cronus and Rhea and was the mother of PERSEPHONE. When Persephone was abducted by Hades, ruler of the dead, Demeter in her grief neglected the Earth's crops. Starvation threatened the world until Zeus urged a compromise whereby Persephone spent six months with Hades (winter) and six months with her mother (summer). Demeter's joy at Persephone's return caused the barren earth to blossom each year. The cult of Demeter featured the ELEUSINIAN MYSTERIES, in which the drama of life, death, and resurrection was enacted. In Roman mythology, Demeter was identified with CERES.

Demetrius I Poliorcetes, King of Macedonia [dih-mee'-tree-uhs, pahl-ee-or-see'-teez] The Macedonian king Demetrius I, *c.*336–283 BC, was the most colorful of the DIADOCHI, or successors of Alexander the

Great. He fought under his father ANTIGONUS I, and after his naval victory (306) over PTOLEMY I, both he and Antigonus assumed the royal title. An unsuccessful siege (305) of Rhodes brought him his surname.

Demetrius conquered Greece as a "liberator" in 304–302, but he was partly to blame for Antigonus's defeat and death (301) at Ipsus. Retaining control of the sea, he seized (294) the throne of Macedonia after some years of confused fighting, but he soon made himself unpopular and lost the kingdom to LYSIMACHUS and PYRRHUS. Invading Anatolia in 287, he had to surrender to SELEUCUS I, and he drank himself to death in captivity.

Demetrius I Soter, Seleucid King [sohl'-tur] Demetrius I, b. *c.*186 BC, of the SELEUCID dynasty, was held hostage in Rome before escaping—with the help of the historian POLYBIUS—and seizing the Seleucid throne in 162. His successes, including a victory over the Jews in which Judas Maccabaeus (see MACCABEES) was killed, brought him into conflict with Attalus II of Pergamum. He died in 150 BC, in battle against a pretender supported by Attalus and Rome.

Demiurge [dem'-ee-urj] *Demiurge*, the Greek word for artisan or craftsman, was a name applied by Plato in the *Timaeus* to the divine craftsman who brought order out of a primeval chaos. In GNOSTICISM the Demiurge, as creator of the material universe, was differentiated from the supreme God and frequently described as the source of evil.

democracy Democracy is a form of GOVERNMENT in which a substantial proportion of the citizenry directly or indirectly participates in ruling the state. It is thus distinct from governments controlled by a particular social class or group (see ARISTOCRACY; OLIGARCHY) or by a single person (see DESPOTISM; DICTATORSHIP; MONARCHY). In a direct democracy citizens vote on laws in an assembly, as they did in ancient Greek city-states and do today in New England towns. In an indirect democracy citizens elect officials to represent them in government; REPRESENTATION is typical of most modern democracies. Today the essential features of democracy, as understood in the Western world, are that citizens be sufficiently free—in speech and assembly, for example—to form competing POLITICAL PARTIES and that voters be able to choose among the candidates of these parties in regularly held ELECTIONS.

Origins of Democracy

The term *democracy* is derived from the Greek words *demos* ("the people") and *kratia* ("rule"). The first democratic forms of government developed in the Greek CITY-STATES during the 6th century BC. In Athens all citizens participated fully in government; minors, women, slaves, and foreigners, however—perhaps 90 percent of the population—were not citizens. Greek democratic institutions collapsed under the onslaught first of Macedonia and later of Rome. Republican Rome had popular assemblies, in which the citizens met to elect officials and make laws. The assemblies lost their powers, however, first to the aristocratic Senate (see SENATE, ROMAN) and ultimately to the Roman emperors. The barbarian invasions and the fall of Rome in the 5th century AD produced a European society that was primarily concerned with security rather than democratic institutions. This gave rise to the rigidly hierarchical systems of FEUDALISM and MANORIALISM. Political attitudes were, moreover, shaped by the powerful Christian church, which taught, in effect, that existing institutions had divine sanction.

Representation. Nonetheless, the Middle Ages saw the establishment of rudimentary representative bodies that began to lay the foundation for the later development of democratic institutions. The medieval kings claimed divine authority to rule, but they relied on their principal baronial vassals for practical advice, rendered in council. Gradually, the councils claimed more than advisory powers, and their membership was expanded to include elected representatives from the knightly and burgher classes. This was the genesis of the modern LEGISLATURE. The British PARLIAMENT traces its history directly to such an institution, and the development of political democracy in Britain can be measured, first, by the gradual assertion of parliamentary supremacy over the hereditary monarch and, second, by the even more gradual transformation of Parliament into a fully representative body (that is, a body elected by the entire adult population on the basis of one person, one vote). In the English Civil War of the 17th century, Parliament briefly won full supremacy over the crown, but it vigorously rejected the constitution proposed by a radical and unsuccessful group known as the LEVELLERS, which called for universal male SUFFRAGE, fair representation, and the abolition of noble privilege.

Popular Sovereignty. The 17th-century philosopher John LOCKE articulated a theory of government that was to be seminal in democratic development. Locke argued that the political state is created by a SOCIAL CONTRACT in which individuals give up their personal right to interpret the laws of nature in return for a guarantee that the community (or state) protect their natural rights of life, liberty, and property. If the state does not fulfill that guarantee, the people have the right to overthrow the government. This idea of popular sovereignty was taken a step further by Jean Jacques ROUSSEAU, who argued that the only legitimate state was one based on the "general will" of the people. Unfortunately, the general will has been difficult to identify in practice; thus this element of Rousseau's thinking has also been viewed as the basis of modern totalitarianism, in which a dictator interprets the general will.

The Lockean tradition was reflected in the DECLARATION OF INDEPENDENCE, which presented the colonists' philosophical justification for the American Revolution and reflected the ideas of Locke and Rousseau; the new United States of America became the first modern democratic state. The same ideas, but with more radical assertions of social as well as political equality, nourished the French Revolution of 1789. France, however, did not achieve real democracy until the Third Republic (1870–1940). During the 19th century democratic forms of government also developed in Britain—where the Reform Acts of 1832, 1867, and 1884 greatly expanded parliamentary suffrage—and in the self-governing British colonies of Australia, New Zealand, and Canada, as well as in Switzerland, Scandinavia, and the Low Countries. All other modern democracies are the product of the 20th century.

In this century most states have called themselves democratic. Many such governments, however, rule in the name of the people without allowing popular participation. During most of the 20th century, this was true in the Communist world, where Marxist-Leninist theorists argued that true democracy is impossible without full economic and social equality, which can be achieved only by overthrowing the capitalist class and establishing a (supposedly temporary) dictatorship of the proletariat. With the rise to power in the 1980s of Soviet leader Mikhail Gorbachev, however, traditional Communist opposition to the ideals of Western democracy began to break down, and Communist theorists abandoned the rigid positions they had held in the past. Communists, at least in some countries, joined with other socialists in working toward their goals through democratic institutions.

Democratic Ideals and Practice

An increase in popular participation in government has often come about because the ruling group sees political advantage in it. In the United States, for example, Jeffersonian Republicans eliminated property qualifications to win the votes of the very poor; progressive reformers in the early 20th century pushed for women's suffrage, expecting that women, more frequently than men, would support humanitarian causes such as temperance; and Republicans and Democrats vied with each other in the 1950s and '60s to promote African-American voting in the South in order to win African-American votes.

Not every expansion of the electorate is so consciously self-serving, however. In colonial America, participation widened almost by accident. Most colonies initially adopted the traditional English property qualification for voting: the 40-shilling freehold. This represented an income that was very high in late medieval times and still fairly high in the 17th century. By 1776 inflation and prosperity had enabled the vast majority of adult males to qualify as electors. In the 20th century some countries, such as Turkey and India, have greatly expanded their electorates as an incidental consequence of the decision to adopt democratic forms. In the latter cases, democracy was adopted because it represented an ideal.

The Ideal of Justice. Democracy attracts support because it represents an ideal of justice as well as a form of government. The ideal is the belief that freedom and equality are good in themselves and that democratic participation in ruling enhances human dignity. The ideal and the practice of democracy are inseparably linked because rulers subject to voter approval are more likely to treat the voters justly. For example, in the United States during the 1920s many African Americans moved from the South, where they could not vote, to the North, where they could and did. In the 1930s this African-Americans vote became critical for both major political parties, and they began to emphasize civil rights. As a result both of Supreme Court decisions and of partisan politics, Southern African Americans obtained voting rights and civil rights. The oppression established in the South in the 1880s has thus been almost eliminated, not simply because of the ideal of justice but because the African Americans became part of the political system. Although full racial equality has not yet been achieved, political participation has encouraged the fair treatment of a minority.

Freedom and Faction. The vote itself is not enough to guarantee that oppression will be eliminated. Many modern dictatorships require almost all adults to vote; yet dissident voices are nevertheless suppressed. For participation to be an effective method or a feasible ideal, it must be accompanied by political liberty. As James Madison wrote in *The Federalist*, "Liberty is to faction as air is to fire." The freedoms that promote faction are important, not only as high moral ideals, but also as a method of realizing democracy.

Almost all traditional freedoms (freedom of speech, freedom of religion, economic freedom) were gained as a result of factional disputes within oligarchical governments. They were extended by persons in office who expected, if and when they left office, to be persecuted by their successors. As factions grew in size, the liberties were gradually extended to the whole electorate and thereby became protections for democratic political parties and freely organized elections.

For example, the speaker at the opening of late medieval English Parliaments petitioned the king to grant members the privilege of not being prosecuted for anything they said in Parliament. As a result, factions flourished within Parliament, but not outside. During the English Civil War censorship and prosecution for assembly were removed, and parliamentary free speech was extended to the general public. Since then, free speech, although not always practiced, has been regarded as an essential element of democratic liberty.

Freedom of religion and economic freedom also originated in the protection of factions. Religious sects were themselves the main political factions in the European wars of the 16th and 17th centuries, and their secular leaders were the most likely to be severely persecuted in defeat. Economic freedom, the privilege of having, keeping, and inheriting property, is protected in the provision against forfeiture for treason in the U.S. Constitution (1787) and is emphasized as a democratic liberty in the American Bill of Rights (1789) and in the French Declaration of the Rights of Man (1789). It has an obvious relation to faction and freedom in general: if governments can seize property without compensation, then dissenters may lose their basis of economic support.

Equality, another ancient ideal, is inseparable from the democratic method. The right to vote means little unless votes are equal and voters have the same influence. Thus equality of treatment under the law is, like freedom, both an ideal and a method of democracy.

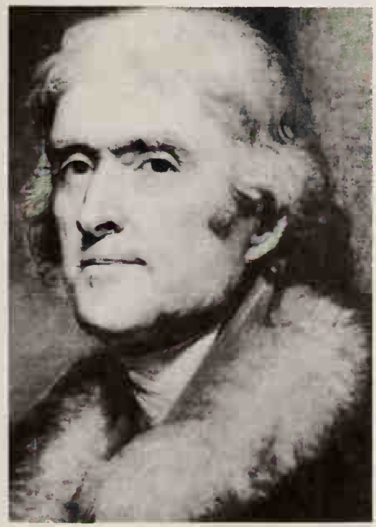
Democracy in America see Tocqueville, Alexis de

Democratic party The Democratic party of the United States is one of the oldest surviving political organizations in the world. Formally established as a national organization by the Democratic-Republican national nominating convention in Baltimore, Md., in May 1832, the party rechristened itself Democratic at its third national convention in May 1840. Together with the REPUBLICAN PARTY, the Democratic party continues to be one of the two major political parties of the nation.

Origins

Party alignments of national consequence began to form before the end of George WASHINGTON's first administration in 1793. Secretary of the Treasury Alexander HAMILTON was the master politician of the FEDERALIST PARTY, which was supported by bankers, businesspeople, and merchants and which favored a strong central government. Secretary of State Thomas JEFFERSON, in cooperation with fellow Virginian James MADISON and joined by the ANTI-FEDERALISTS, led what came to be the first loyal opposition in national affairs—the Democratic-Republican party, also known as the Jeffersonians. Jefferson spoke on behalf of the interests of farmers, veterans, and urban immigrants and was in favor of minimum government and maximum liberty. In 1792 he and Madison allied with New York's Governor George Clinton (see CLINTON family), creating the first political coalition between Northern and Southern politicians—a coalition that would later serve as a pillar of the Democratic party. TAMMANY HALL in New York City, under the leadership of Aaron BURR, became part of the coalition.

From about 1792 to 1800 the Democratic-Republican party was the beneficiary of the rise of numerous patriotic societies throughout the states, mainly in urban centers. Party organization also advanced in Congress. By the 4th Congress (1795–97), Democratic-Republicans held enough seats to challenge the dominant Federalists, and they held their first congressional CAUCUS on Apr. 2, 1796. The caucus became a principal instrument of Jeffersonian power during the next two decades. It nominated Jefferson, Madison, and James MONROE for the presidency, nominations that were tantamount to election.


Thomas Jefferson, the third president of the United States, led the Anti-Federalist political group from which the present Democratic party developed. Known as the Democratic-Republican party, it was a loose coalition that favored farming interests and minimum government.

During the era of Andrew Jackson, political satirists began to use the donkey as a symbol, first of Jackson himself and later of the Democratic party. In this 1837 cartoon Jackson rides a donkey burdened with the hard currency demanded by his Specie Circular.

After the election (1800) and reelection (1804) of Jefferson to the presidency, Federalist strength tended to decline everywhere except in New England. The administrations (1817–25) of James Monroe were designated the Era of Good Feelings, meaning that there were no real party divisions; in fact, it was a period of one-party politics dominated by the Jeffersonians. This situation ended with a split among the Democratic-Republicans in 1824. In the election of that year the popular vote for presidential electors gave Andrew JACKSON a plurality rather than the necessary majority in the electoral college. Under the Constitution, the final choice fell to the House of Representatives, where Speaker Henry CLAY withdrew his own candidacy in favor of John Quincy ADAMS. The outraged Jacksonians vowed to correct the betrayal of the popular will at the next election and began to organize immediately to this end. They were joined by New York's Senator Martin VAN BUREN, leader of the Albany Regency, a party machine whose influence extended well beyond that state. Jackson defeated Adams in the 1828 election.

Jacksonian Incorporation of the National Party

The organizing genius of Van Buren and of Jackson's political associates from Tennessee eventually restructured the national Democratic-Republican party as well as the presidential system of government. Jackson's advisors in party matters, dubbed the KITCHEN CABINET, were instrumental in developing party organization in the states and achieving programmatic cohesion in Congress. The Jacksonian leadership promoted extension of the suffrage to practically all white male citizens, thereby bringing urban workers into the electoral process and the Jacksonian coalition. At the Democratic-Republican nominating convention of 1832—its first—Jackson was renominated, and the convention adopted the requirement of a two-thirds vote to make nominations. The two-thirds rule tended to magnify the strength of minority factions in the party and severely handicapped its capacity to achieve conciliatory coalitions over the next hundred years.

During his eight years in office, Jackson was able to surmount the competing demands of various Democratic-Republican factions. However, the seeds of a most fundamental issue were planted by South Carolina's demand for tariff reduction. Led by former Vice-President John C. Calhoun, a special convention in that state called for the nullification of the tariffs of 1828 and 1832 on grounds that any state had the sovereign right to nullify a federal law. The crisis caused by this extreme state rights position was ended by a compromise in 1833, but the basic issues remained unresolved. The right of states to nullify led inevitably to the question of whether states had the right to secede.

Slavery, Civil War, and Reconstruction

As Americans moved westward into the territories acquired from 1803 to 1848, slavery became the overwhelmingly dominant issue, with proslavery and antislavery forces engaging in a contest for control of the new territories that were soon to be brought into the Union as either free states or slave states. In view of its dependence on popular support in both the North and the South, the Democratic party was under particular pressure to forestall bloodshed at the frontiers, moderate the adamant abolitionists of the North, and maintain the agriculture economy, slave supported though it was, of the South.

The issues so fragmented the party that its next several presidents were able to maintain themselves in office for only one term each: Van Buren (1837–41), James K. Polk (1845–49), Franklin Pierce (1853–57), and James Buchanan (1857–61). The climax of the party crisis came in 1860. The party split, and separate conventions of Southerners and Northerners nominated John C. Breckinridge and Stephen A. Douglas, respectively. The division gave the election to Abraham Lincoln, the nominee of the newly created Republican party. Secession and civil war followed.

The war and, later, reconstruction, removed Southern Democrats from national politics. The Radical Republicans in Congress, proponents of a vindictive Reconstruction policy after the war, kept the Democrats divided by harassing Andrew Johnson, who had succeeded to the presidency upon Lincoln's assassination, and by legislating a military occupation of the South that kept those states Republican through most of the Reconstruction period.

Woodrow Wilson won the Democratic presidential nomination in 1912 on the 46th ballot. The future president is depicted here astride the party mascot, with his running mate, Thomas R. Marshall, hanging on by the tail.

A final crisis was the disputed Hayes-Tilden presidential election of 1876, the outcome of which rested upon the disputed returns of three Republican-controlled states in the South. Although the Democrat Samuel J. Tilden won a majority of the national popular vote, Democrats acquiesced to Rutherford B. Hayes's election in exchange for ending the federal occupation of the South. The way was paved for a return of Southern Democrats to local power and to participation in the affairs of the national party.

In the post–Civil War period, the Democratic party had to confront the flagrant corruption of certain Democratic city machines such as the Tweed Ring (see Tweed, William M.) of New York and the conflict between the easy-credit agrarian interests of the West and the sound-money commercial and banking interests of the East. In search for a unifying platform, Tilden made reform his grand issue: reform in the cities, now crowded with immigrants and industrial workers; and reform in the presidency, beset by scandal during the administrations (1869–77) of Ulysses S. Grant. By 1884, Tilden was ready to turn the reins of party leadership over to his fellow New Yorker, Gov. Grover Cleveland. Southern Democrats were by now well along in creating the "Solid South," a one-party Democratic section, by driving African-American Republicans out of office and making it impossible for African Americans to participate either as Democrats or as voters.

The Democratic revival put Cleveland into the presidency. He supported civil-service reform and tariff rates sufficient for revenue purposes only. Farmers, always needing cheap currency and easy credit, began to press for conversion of the wholly gold-standard currency to one using both gold and silver as legal tender. Cleveland was steadfast in his support of gold. Party leaders in the South and the West insisted, however, on a liberal coinage of silver currency. Free silver was the issue that made William Jennings Bryan the party's nominee for president in 1896. Renominated in 1900 and 1908, Bryan popularized such reforms as a federal income tax, direct election of U.S. senators, women's suffrage, and public accountability for campaign expenditures. His progressivism was echoed in many of the policy postures of Woodrow Wilson, the reform governor of New Jersey, who was nominated in 1912. The Wilsonian program established the Federal Reserve System, a new railroad labor arbitration process, antitrust rules, farm-loan banks, and similar progressive legislation.

New Deal and Fair Deal

Wilson was unable to rally Democratic voters to support his vision of a League of Nations. His illness left the national convention of 1920 leaderless and so divided that 44 ballots were needed to nominate James M. Cox. The 1924 national convention ran for 103 ballots. In 1928 two of many party factions, the city machines and the progressives, joined to nominate Gov. Alfred E. Smith of New York, the first Roman Catholic to receive a presidential nomination. Although Smith attracted millions of recent immigrants to the poll for the first time, he lost much of the normally solid South.

The Depression of the 1930s and the nomination of Franklin D. Roosevelt reunited the Democratic party in 1932. Roosevelt's New Deal, and his unprecedented three-time reelection (1936, 1940, and 1944) brought together a political coalition that made the Democrats the nation's majority party for the next half-century. Roosevelt managed to unite important segments of union labor, small farmers, liberal intellectuals, consumer-oriented businessmen, urban machines, Catholics, Jews, Southerners, African Americans, and several ethnic minorities.

Franklin Delano Roosevelt is sworn in at his first inauguration, in 1933. Reelected three times (1936, 1940, 1944), Roosevelt created a series of programs, the New Deal, to combat the Depression, and he led the nation in World War II.

Harry S. Truman displays an early edition of the Chicago Tribune, which mistakenly reported his defeat in the election of 1948. Truman, behind in every major poll, defeated Republican candidate Thomas Dewey with one of the most vigorous campaigns in modern American political history.

The New Deal era wrought many structural changes in the Democratic party. As the patronage and social services of the federal government grew more pervasive, the functions and resources of Democratic machines in the cities diminished. Old bosses (see boss, political) began to be swept away by reformers, and old machines began to wither. With the repeal (1936) of the two-thirds nominating rule in the convention, the influence of the Southern wing declined. Organized labor became active in grass-roots registration and election campaigns. The World War II military experience of many African Americans and the migration, during and after the war, of many African Americans from the South to the manufacturing centers of the North stirred awareness that led to the civil rights movement of the 1950s and '60s.

Reelected for a fourth term in 1944, Roosevelt died soon after and was succeeded by Harry S. Truman, whose Fair Deal program was dominated by his defense of organized labor and his vigorous support of civil rights programs for African-American citizens. Many Southern Democratic leaders registered their disapproval by supporting the Dixiecrat ticket in 1948.

Truman declined to run for reelection in 1952, and the party nominated Adlai E. Stevenson (see Stevenson family), who made a determined effort to improve party organization. Stevenson's Republican opponent, however, was the popular World War II general Dwight D. Eisenhower, who won handily. Eisenhower also won the votes of substantial numbers of Southerners, a phenomenon that helped bring competitive two-party politics to the South and diminished or eliminated the racially discriminatory character of most state and local Democratic party practices in that section.

New Frontier, Great Society, and Vietnam

In 1960, John F. Kennedy recovered the presidency for

John F. Kennedy's campaign for the 1960 Democratic presidential nomination included numerous public appearances and speeches. Kennedy received the nomination on the first ballot and went on to defeat Richard Nixon for the presidency.

the Democrats. Kennedy came from a family long involved in Boston machine politics and was the first Catholic elected president. His liberal New Frontier program and his active support of the civil rights cause led to significant new legislation, most of which was passed, however, under his successor.

Kennedy's assassination, in Dallas in November 1963, brought his vice-president, Lyndon B. Johnson of Texas, to the presidency. Johnson proved an ardent supporter of social reform. His administration was notable for Great Society programs of educational, welfare, and civil rights legislation, as well as for its devastating failures in connection with the Vietnam War. The war divided the Democratic party and the nation with a bitterness reminiscent of the Civil War period.

Crystallizing the opposition to Johnson's policies in Vietnam, Sen. Eugene McCarthy of Minnesota and Sen. Robert F. Kennedy of New York, John Kennedy's brother, sought the presidential nomination in 1968. Gov. George Wallace of Alabama, hoping to capitalize on racial tensions in the cities and the South, prepared his own challenge. After his narrow win over McCarthy in the New Hampshire primary election, Johnson announced that he would not be a candidate. Vice-President Hubert H. Humphrey then entered the race and won the nomination at the tumultuous convention in Chicago. The disarray at the convention, where antiwar demonstrators clashed with Mayor Richard Daley's Chicago police, blemished Humphrey's cause and contributed to his defeat by Richard M. Nixon. Another source of Democratic weakness in 1968 was the massive defection of blue-collar and Southern voters to Wallace's third party.

The party's wounds persisted for the next half-dozen years. At the 1972 nominating convention antiwar, African-American, young, and women delegates were pitted against labor and party regulars. Humphrey was defeated for the nomination by Sen. George McGovern, who stressed party reform and an end to the Vietnam War. Feeling ran high: McGovern was unable to unite the factions, and he carried only Massachusetts and the District of Columbia.

When President Nixon was driven from office by the Watergate scandal in 1974, the Democrats were ready to reunite. Jimmy Carter, former governor of Georgia, captured the Democratic presidential nomination in 1976. Aided by an unusually high turnout of African-American voters, especially in the South, he won a close race against President Gerald R. Ford.

The Carter presidency, however, marked a precipitous decline in the fortunes of the Democratic party. Relations between President Carter and the Democratic Congress were never close, and many of Carter's initiatives were blocked. His administration was plagued by a reputation for inefficacy and weakness at home and abroad. Carter's energy initiatives were stalled and watered down, inflation rates soared, U.S. citizens were captured and held hostage in Iran, and the USSR occupied Afghanistan. Republican candidate Ronald Reagan easily defeated President Carter in 1980. The Democrats kept a majority in the House of Representatives; the Republicans won their first Senate majority since 1954.

In the 1984 campaign the Democratic candidate, former Vice-President Walter F. Mondale, broke with tradition by choosing a woman, N.Y. Rep. Geraldine Ferraro, as his running mate. The popular President Reagan overwhelmed them at the polls. The Democrats retained their majority in the House, although it was diminished, while the party gained two seats in the still-Republican-dominated Senate. The Democrats, however, recaptured the Senate, 55–45, in the 1986 midterm elections, and boosted their House majority. The 1988 presidential campaign between Massachusetts governor Michael Dukakis, a Democrat, and Vice-President George Bush ended with another Republican victory—although the Democrats increased their congressional majorities.

Michael Dukakis, the Democratic presidential candidate in 1988, and his wife, Kitty, take center stage at the party's convention in Atlanta. Although the Democrats lost the presidential election in 1988, they increased their majorities in Congress.

The Contemporary Democratic Party

Throughout its history the Democratic party has called itself the party of the people, a title that was justified by its traditional support, which tended to be less prosperous, less skilled occupationally, and less educated than Republicans. Nevertheless, the party learned in 1980 that it could no longer take for granted the votes of groups that had been traditionally ranked among the Democrats. Disaffection with Carter's economic policies sent many union members and African Americans over to the Republican side, and the once solidly Democratic South now had a healthy two-party system. Although the 1982 and 1986 midterm elections showed resurgent Democratic strength, the 1988 election was a rerun of the Republican presidential triumphs of 1980 and 1984.

Democritus [dem-ahk'-rit-uhs] Democritus, *c.*460–*c.*370 BC, a Greek philosopher, developed and systematized classical ATOMISM, a theory credited to his teacher LEUCIPPUS. The theory postulated a world made up of hard, indivisible (hence atomic, from Greek *atoma,* "uncuttable") particles of matter moving through empty space.

According to Democritus, the atoms had shape, mass, and motion but no other qualities, such as color or flavor. These latter were supplied by the observer and were subjective. Democritus described them as existing by convention or by custom (*nomos*), as opposed to existing by nature (*physis*). All change was to be explained by reference to the transfer of momentum as the atoms collided. Democritus suggested that our cosmos was formed by a spinning vortex of such atoms and that there were an infinite number of worlds formed in the same way.

Democritus's belief in the unchanging nature of the intelligible universe and the changing nature of the sensible universe was a direct confrontation of the ideas of PARMENIDES, who denied all change, and HERACLITUS, who denied all constancy. His ethics was also a path between the extremes of these two philosophers. Democritus's ethical naturalism rejected any teleology or belief in chance that would deny people's responsibility for their own well-being. He rejected all supernatural sanctions of human behavior, thought that belief in an afterlife was a ridiculous fiction, and held that it was an individual's conscience alone that determined right or wrong action.

demography Demography is the scientific study of the size, distribution, and composition of human POPULATIONS. Demography, a branch of sociology, uses birth and death rates, marriage and divorce rates, employment rates, and other related statistics to determine the characteristics of a specific population, discover patterns of change, and make predictions.

One of the most important demographic tools is the life table. Originally taken over from actuarial methods, the life table converts the numbers of deaths in a population to probabilities of dying and life expectancies. It is applicable to specific causes of death as well as to mortality in general and to other phenomena, such as the probability that students will drop out of school or that contraceptives will fail.

Areas of specialization within demography include the analysis of stable populations, first performed by the 18th-century Swiss mathematician Leonhard EULER. The American mathematician A. J. Lotka (1880–1949) contributed much to renewal theory, a branch of mathematical statistics concerned with population evolution and change. Population projection, or forecasting, uses techniques that apply as well to the study of plant and animal populations.

Demography is used to ascertain relations among the components of a population, such as that between age groups. Age distribution has a direct bearing on the costs of schooling and of pensions, the demand for housing, and the need for many other commodities. The baby boom in the United States following World War II and the subsequent aging of the population have caused the most remarkable demographic shifts ever experienced in the country.

In every society where industrialization and modernization have occurred, the birth as well as the death rate has fallen. Demographers are particularly concerned with the time lag between the fall in the death rate and the subsequent fall in the birth rate. They also want to know what social factors underlie the observed differences in FERTILITY among different income, educational, ethnic, religious, and residential categories that might affect future patterns.

demolition see EXPLOSIVES

demon [dee'-muhn] A demon is an evil spirit. The word is derived from the Greek *daimon,* which in ancient times signified spirits that were not specifically evil. *Daimon* came to mean an evil spirit in the Septuagint (*c.*275–100 BC), the earliest Greek translation of the Hebrew Bible. In the Latin Vulgate (5th century AD), *daemon* was used to refer to idols and pagan gods in general, as well as to spirits that might take possession of human beings. In traditional belief, such spirits were thought to be responsible for sickness, and could be expelled by means of EXORCISM.

Belief in evil spirits is widespread in traditional cultures all over the world. In many tribal societies they are held to be the ghosts of dead ancestors who are hostile to the living and must be placated by magical rites.

Various kinds of demons figure in the Hindu tradition. The *asuras* are spirits associated with drought. The *raksasas*—goblins who take the form of animals and deformed humans—are believed to devour corpses. Vritra, the adversary of the god Indra, is the Hindu counterpart of the Judeo-Christian tradition's SATAN.

Mara, the Buddhist Satan, leads an army of demons depicted in Buddhist art as hideous monsters similar to the devils that torment the damned in medieval European portrayals of hell. The demons that are a common subject of Tibetan iconography were originally nature spirits who have been tamed by the power of Buddhist saints.

The *jinni* of Islamic folklore is a desert spirit that may be either benign or malicious. Foremost among the latter is Iblis, an angel who rebelled against God and was driven out of paradise.

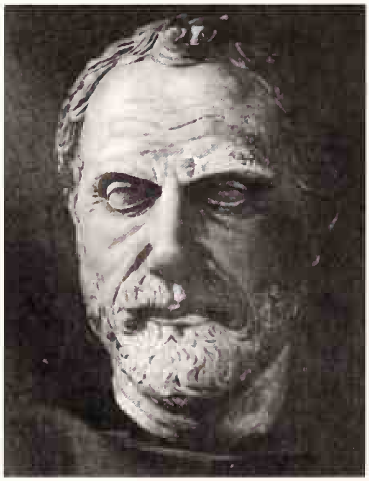
Demons represented in the Jewish tradition include Azazel, a desert spirit connected with the rites of atonement (Lev. 16:8), and LILITH, the first wife of Adam, who was believed to steal and kill children. Prominent in the folklore of eastern European Jewry since the 17th century is the *dibbuk*, a demon that takes possession of people and speaks through them, causing them to behave in a demented manner.

In the Christian West, belief in demons was a major element in the religion of medieval and early modern Europe. One of its chief manifestations was the WITCHCRAFT craze of the 16th and 17th centuries.

Demosthenes [dem-ahs'-then-eez] Demosthenes of Athens, b. 385 BC, was possibly the greatest orator of ancient Greece. Many of his orations, including private legal suits, attacks on politicians, and public orations on Athenian policy, are preserved. Oratory was for him a driving ambition. He practiced his delivery—according to legend, by putting pebbles in his mouth—and studied the masters of Athenian prose to perfect his skills. The result was an exciting and explosive style, although Demosthenes could be plain with great rhetorical effect.

He commenced his political career in 351 when he delivered the first of his four Philippics against PHILIP II of Macedonia, whom he correctly feared would extinguish Greek liberty. The Athenians wavered until 338, when Demosthenes united Athens and Thebes against Philip, but the Greek cause was irretrievably lost at the Battle of Chaeronea.

Demosthenes pursued his anti-Macedonian policy after Philip's death in 336. He opposed ALEXANDER THE GREAT by collaborating with a defecting lieutenant of Alexander's, Harpalus. As a result, Demosthenes was exiled from Athens, although he returned after Alexander's death in 323. A year later the Macedonians reasserted their control of Greece and demanded his execution. Demosthenes ended his life by poison.



The Athenian orator Demosthenes delivered his first major political speech in 351 BC. For the next 13 years he eloquently warned against the Macedonian threat to Greece. A forceful speaker, Demosthenes combined wit and rhetorical skill to achieve an unmatched eloquence.

Dempsey, Jack William Harrison "Jack" Dempsey, b. Manassa, Colo., June 24, 1895, d. May 31, 1983, was one of the most famous and highly regarded of heavyweight boxing champions. Nicknamed the "Manassa Mauler" by sportswriter Grantland Rice, Dempsey is one of the legendary heroes of American sports. His $2.66 million fight with Gene TUNNEY (Sept. 22, 1927) was the biggest gate in boxing before the television era.

Despite more than 100 bouts from 1911 to 1916, Dempsey received little recognition before 1917. Under Jack "Doc" Kearns's tutelage, however, he quickly rose in the ranks and became champion in 1919 when he knocked out Jess Willard. Dempsey's savage right hand, ferocious style, and flamboyance earned him a popular reputation that lasted his entire life. Tunney took the heavyweight crown from Dempsey on Sept. 23, 1926, in what was considered an upset. Their return match, which Dempsey eventually lost, became known as the controversial "long count" fight: in the bout, Dempsey knocked Tunney down for what ringside experts said was 13 seconds, or 3 more than the allotted count. Of Dempsey's 78 recorded fights, he won 72 (49 by knockout) and lost only 6.

Jack Dempsey, a brawling, aggressive prizefighter, won the world heavyweight championship in 1919 by knocking out Jess Willard, an opponent who outweighed him by 26 kg (57 lb). Dempsey held the championship for 7 years, until Gene Tunney wrested the title by a decision in 1926.

Demuth, Charles [day'-mooth] The American artist Charles Demuth, b. Lancaster, Pa., Nov. 8, 1883, d. Oct. 23, 1935, is known both for his delicate and imaginative watercolors and for his later work in the precisionist, or cubist-realist, manner.

Demuth's watercolors include fruit and flower studies, scenes of acrobats, and landscapes based on those of Paul Cézanne. His precisionist subjects, treated with a

The flat forms of Charles Demuth's My Egypt *(1927) show the European influence of cubism but were inspired by the angular, functional shapes of grain elevators, a feature of the American landscape. (Whitney Museum of American Art, New York.)*

flattening and simplification of form, include architectural and industrial scenes, such as the grain elevators in *My Egypt* (1927; Whitney Museum, New York City).

Demuth also painted watercolor illustrations for stories dealing with the perverse, for example Émile Zola's *Nana* (1916) and Henry James's *The Turn of the Screw* (1918). In the 1920s he painted several cryptic poster portraits, assemblages of various objects that served as clues to the unseen subject, as in *I Saw the Figure 5 in Gold* (1928; Metropolitan Museum of Art, New York City), based on a poem by William Carlos Williams.

denarius [duh-nair'-ee-uhs] The denarius was a silver coin first issued by the Romans about 150 BC and used until the 3d century. The later denarii became progressively debased in value and contained more and more copper. The present-day dinar of several Mediterranean countries is descended from the denarius. Before Great Britain's currency shifted to the decimal system in 1971, the British penny was abbreviated as d, for denarius.

denatured alcohol see ETHYL ALCOHOL

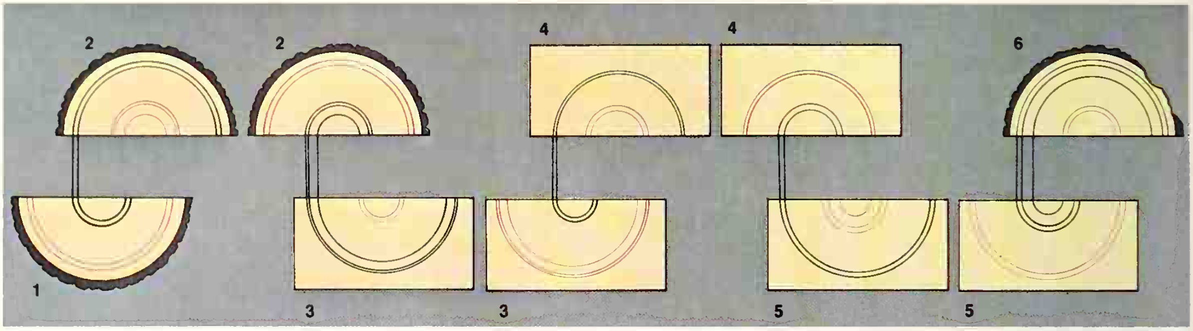
Denbighshire see CLWYD

dendrochronology [den-droh-krahn-ahl'-uh-jee] Dendrochronology is the science of using tree rings to date ancient buildings and events or to reconstruct past environmental conditions. Dates have been obtained on such things as past volcanic and glacial activity, earthquakes, and archaeological remains.

History. The American astronomer Andrew Ellicott Douglass (1867–1962) established the principles of dendrochronology. Observing that annual tree rings may be wide in wet years and narrow in dry years, he demonstrated that ring-width patterns are unique for particular time periods; thus the ring widths can be used to date the time that a piece of wood was a growing tree and to deduce past climatic changes that influenced its growth. Applying the tree-ring dating method to archaeological ruins in the U.S. Southwest, he dated 40 major ruins by linking ring-width patterns in ancient wood with those in living trees. In 1937, Douglass established the Laboratory of Tree-Ring Research at the University of Arizona, Tucson, today the largest institute of its kind. Tree-ring dates have since been assigned to more than 50,000 archaeological specimens gathered from more than 1,200 separate sites in the Southwest. BRISTLECONE PINE, *Pinus aristata,* from California, which lives to an age of more than 4,500 years, supplies the longest American tree-ring record, almost 8,700 years. A continuous series of about 7,300 years has been established for buried oak wood in Europe.

Methods. Living trees are sampled with a tool that extracts a core 4 mm (0.16 in) in diameter; 20 to 100 cores are taken from the oldest trees at each site. The cores are studied in a laboratory, where the ring-width patterns on all samples from a site are compared. When all rings are clearly annual and only one exists per year, dendrochronology is relatively straightforward. In places such as the arid U.S. Southwest, however, some trees may not grow a ring every year, whereas others will occasionally produce two or more rings in certain years. The dendrochronologist identifies these problems by examining the synchroneity of the ring-width patterns among samples. A discrepancy in synchroneity occurs where either an extra ring exists or a ring is missing. The dendrochronologist determines the cause of the discrepancy,

Dendrochronology, a means of determining dates by counting tree rings produced during annual growing seasons, was developed in 1929 by Andrew E. Douglass, an American astronomer.



Dendrochronology, or tree-ring dating, is a method used by archaeologists to determine the age of ancient wood objects. A growing tree produces one ring each year, which means that it can be dated by counting its rings. Trees of the same species grown in the same area produce matching ring sequences; thus rings in a tree stump of known cutting date (1) *allow determination of the age of an older stump* (2) *by matching the ring patterns. The older stump can, in turn, be matched with a wood beam to determine its age* (3). *This cross-matching process can be continued with still older beams* (4,5), *which are then used to date a prehistoric stump* (6).

makes the changes necessary to remove it, and then rechecks the synchroneity. A date is then assigned to each ring, and the chronology of the ring-width variation is checked against the chronology of variation from trees in neighboring sites. Discrepancies are rarely found, but when one is, all materials are rechecked until agreement is reached. A chronology from living trees is extended backward in time by comparing cores with older samples of unknown age.

Individual ring widths or other characteristics are measured, entered onto computer files, and processed to minimize extraneous nonclimatic information. The ring widths are converted to relative values called indices, which are averaged for each year to obtain a chronologic record. Other computer techniques are used to calibrate the indices with climatic factors, such as temperature and precipitation. Calibration is analogous to marking the glass tube of a mercury thermometer so that the height of the mercury column can be read as temperature.

Several chronologies can be calibrated with climatic data from a nearby weather station, or an array of chronologies throughout a region can be calibrated. Past growth values can then be used to construct regional maps of past climatic variations. Such reconstructions have greatly extended the knowledge of past climates, including droughts, unusually warm and cold periods, volcanic eruptions (see Thera), earthquakes, floods, and other environmental conditions.

See also: PALEOCLIMATOLOGY.

Deng Xiaoping (Teng Hsiao-p'ing) [duhng shee-ow'-ping] Deng Xiaoping, b. Sichuan (Szechwan) province, 1904, is one of the towering figures of the Chinese Communist party (CCP). He joined the Communist Youth League in 1922 and the CCP in 1924 and studied in France and the Soviet Union in the 1920s. A veteran of the Long March, Deng was a senior political officer in the Red Army from 1927 to 1949 and became a member of the party Central Committee in 1945.

From 1949, when the People's Republic of China was established, Deng was among the most senior officials in southwest China. In 1952 he was transferred to Beijing, where he advanced to become a vice-premier of the State Council (1952), a politburo member (1955), and party general secretary (1956) and served as a key negotiator in the troubled relationship with the USSR. In the early stages of the Cultural Revolution, however, Deng was denounced as a "capitalist roader" and dismissed from all his posts. He returned to a top political role in 1973, was again purged in 1976, and was brought back to senior government, party, and military posts in mid-1977, after Mao Zedong's death.

In the period from 1977 to 1980, Deng outmaneuvered party leader Hua Guofeng to become China's paramount leader, although he did not assume the seemingly most senior posts in the party or the government; in 1987 he resigned from the politburo, although he remained head of the Central Military Commission until 1989. After 1978 he was the man chiefly responsible for China's rapid economic modernization, although his efforts to or-

Deng Xiaoping is China's ultimate survivor. Twice purged by Mao Zedong, Deng became China's foremost leader by dominating three key hierarchies—the army, government, and Communist party. In the 1980s, Deng was the driving force behind China's economic modernization and the transfer of power to a younger generation.

chestrate an orderly transfer of power to a younger generation were less successful. He endorsed the June 1989 crackdown on the student prodemocracy movement and later declared that China must pay more attention to ideology while continuing its reform policies.

dengue fever [deng'-gee] Dengue fever, a sporadically epidemic disease of warmer climates, is caused by a virus transmitted by the *Aedes* mosquito, which also spreads yellow fever. Although painful, dengue fever usually ends in complete recovery within a few weeks; its symptoms include acute fever, joint pains, headache, fatigue, sweating, and a rash. In southeastern Asia, however, a severe form of the disease called dengue hemorrhagic fever has caused numerous deaths in children in recent years, and a similar pattern is now being observed in the Americas. During the 1980s, dengue fever was observed to be spreading through Mexico and approaching the southern United States. No vaccine against the disease is yet available.

denim [den'-uhm] Denim is the material used to make blue jeans and is currently one of the world's most popular fabrics. It is usually a fairly heavy, durable cloth made with a blue cotton warp and a white cotton filling. Denim is also used extensively for skirts, jackets, and children's clothing. The blue in all-cotton denim is usually produced by a process called range-dyeing: the yarn is run through indigo dye, and the color is then fixed by exposing the yarn to the air. Range-dyeing allows the blue in the fabric to fade gradually, a desirable quality in denim.

Denis, Saint A 3d-century bishop and martyr, Denis is the patron saint of France. According to tradition he was a missionary to Gaul and was beheaded at Montmartre ("martyr's hill") in Paris. Legend identified him with Dionysius the Areopagite of Acts 17:34 and with the 5th-century mystical theologian called DIONYSIUS THE PSEUDO-AREOPAGITE. Feast day: Oct. 9.

Denis, Maurice [duh-nee'] Maurice Denis, b. Nov. 25, 1870, d. Nov. 13, 1943, was a French artist and one of the founding members of the NABIS (Hebrew for "prophets"). He stated in 1890 that "a picture—before being a war-horse, a nude woman, or some sort of anecdote—is essentially a surface covered with colors arranged in certain order." Denis's paintings of the 1890s emulate Gauguin's in their decorative qualities and anticipate the patterns of Art Nouveau. After 1900, Denis became increasingly occupied with religious art based on early Italian painting, especially the works of Fra Angelico.

Denishawn [den'-i-shawn] Denishawn was the popular name of the dance company and network of schools (Denishawn School of Dancing and Related Arts) established by Ruth ST. DENIS and Ted SHAWN in 1915 that laid the foundation for American dance.

The Denishawn troupe crisscrossed the United States on concert tours and in vaudeville, presenting dances adapted from exotic sources that impressed audiences with their spirituality as much as their pageantry. The troupe toured the Orient in 1925–26. Denishawn's schools embodied Shawn's philosophy that no one system of dance could embrace all of dance. Classes covered ballet and dramatic and ethnic dance and were supplemented with instruction on dance history, religious aspects of dance, and theatrical production.

Denishawn trained the first generation of American modern dancers (see MODERN DANCE), including Martha Graham and Doris Humphrey. It also brought dance into direct contact with the American public, thus building a large audience for dance as art. It disbanded in 1932.

Denmark Denmark is the smallest of the Scandinavian nations other than Iceland. Located between the North Sea on the west and the Baltic Sea on the southeast, Denmark is separated from Norway by the SKAGERRAK and from Sweden by the Kattegat and the Øresund. In the south, it shares a 68-km (43-mi) border with Germany. The FAEROE ISLANDS and GREENLAND have been part of Denmark since the 14th century and are now self-governing units within the nation.

During the 9th century the name Denmark (*Danmark:* "border district of the Danes") was used for the first time. Subsequently, Denmark ruled over much of Scandinavia, which developed a common Nordic culture. At the same time, Denmark has also been influenced by German culture.

Today, Denmark's balanced economy, in which much of its agricultural and industrial output is exported, gives the country one of the highest standards of living in the world. Through high taxes, Denmark enjoys one of the most advanced systems of government-provided welfare and social services.

Land and Resources

Most of Denmark consists of JUTLAND, a peninsula jutting into the North and Baltic Seas. Covering 29,766 km^2 (11,492 mi^2), Jutland accounts for about 70% of Denmark's area. The rest of the land consists of nearby islands, including ZEALAND, Bornholm, Falster, Fyn, and Lolland, and approximately 500 smaller islands, about 100 of which are inhabited.

More than 75% of Denmark lies below 100 m (330 ft). During the Quaternary Period (the last 2 million years), Denmark was totally or partially covered by ice sheets at least four times. The limit of the most recent ice advance is marked in Jutland by an end moraine that forms a range of low hills extending north-south through the peninsula. Most of western Jutland was not glaciated during the last ice advance and is marked by occasional undulating areas of older glacial deposits and extensive flat areas underlain by sands and gravels washed westward from the melting glacier. Eastern Jutland and the

AT A GLANCE

KINGDOM OF DENMARK

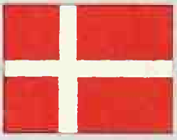
Land: Area:43,069 km^2 (16,629 mi^2). Capital and largest city: Copenhagen (1988 est. pop., 468,704).

People: Population (1990 est.): 5,131,217. Density: 119.1 persons per km^2 (308.5 per mi^2). Distribution (1989): 84% urban, 16% rural. Official language: Danish. Major religion: Evangelical Lutheranism.

Government: Type: constitutional monarchy. Legislature: Folketing. Political subdivisions: 14 counties, 1 city.

Economy: GNP (1989): $73.7 billion; $14,300 per capita. Labor distribution (1988): services—51%; government—8%; manufacturing—34%; agriculture—7%. Foreign trade (1989): imports—$26.4 billion; exports—$27.7 billion; Currency 1 Danish Knone = 100 øre.

Education and Health: Literacy (1989): 100% of adult population. Universities (1989): 5. Hospital beds (1987): 32,325. Physicians (1987) 13,144. Life expectancy (1990): women—79; men—73. Infant mortality (1990): 6 per 1,000 live births.



islands, which were covered by the most recent ice advance, have a more rolling landscape dotted with many small lakes. The highest point in the country, Yding Skovhøj, rises to 173 m (568 ft) in east central Jutland.

Soils. In western Jutland sandy podzolized soils, of low natural fertility, are dominant. Until agricultural advances in the last century made these soils arable, almost all this land was covered by heath. The rest of Denmark has various types of brown soils that are the most productive soils in the country. In addition, many areas once covered with bogs and swamps have been drained and are now cultivated.

Climate. Denmark has a temperate marine climate, which is mild for its latitude. The country receives the heating effect of the North Atlantic Drift, part of the warm Gulf Stream. The mean temperature for February, the coldest month, is –0.4° C (31° F), and for July, the warmest month, 17° C (63° F). Average precipitation is 664 mm (26 in) annually. July and August are the wettest months, and the spring months are the driest. Denmark is subject to marine and continental air masses, and great differences occur in the day-to-day weather.

Drainage. Denmark's glacial landscape contains many small streams and lakes. The longest river, the Gudenå in Jutland, is 158 km (98 mi) long. The largest lake, Arresø in northern Zealand, covers 41 km^2 (16 mi^2). Denmark has many water bodies with brackish water (gulfs, inlets, lagoons). In many places water courses have been regulated to reclaim land for agriculture.

Vegetation and Animal Life. Denmark is part of Europe's temperate deciduous forest belt. The natural vegetation in most of the country is a mixed forest, with beech the predominant tree. However, almost all parts of the country are under cultivation today. Coniferous trees prevail in parts of the former heath areas in western Jutland, and the dune areas have been forested with spruce and pine. Denmark has a 12% forest cover, and it is being extended.

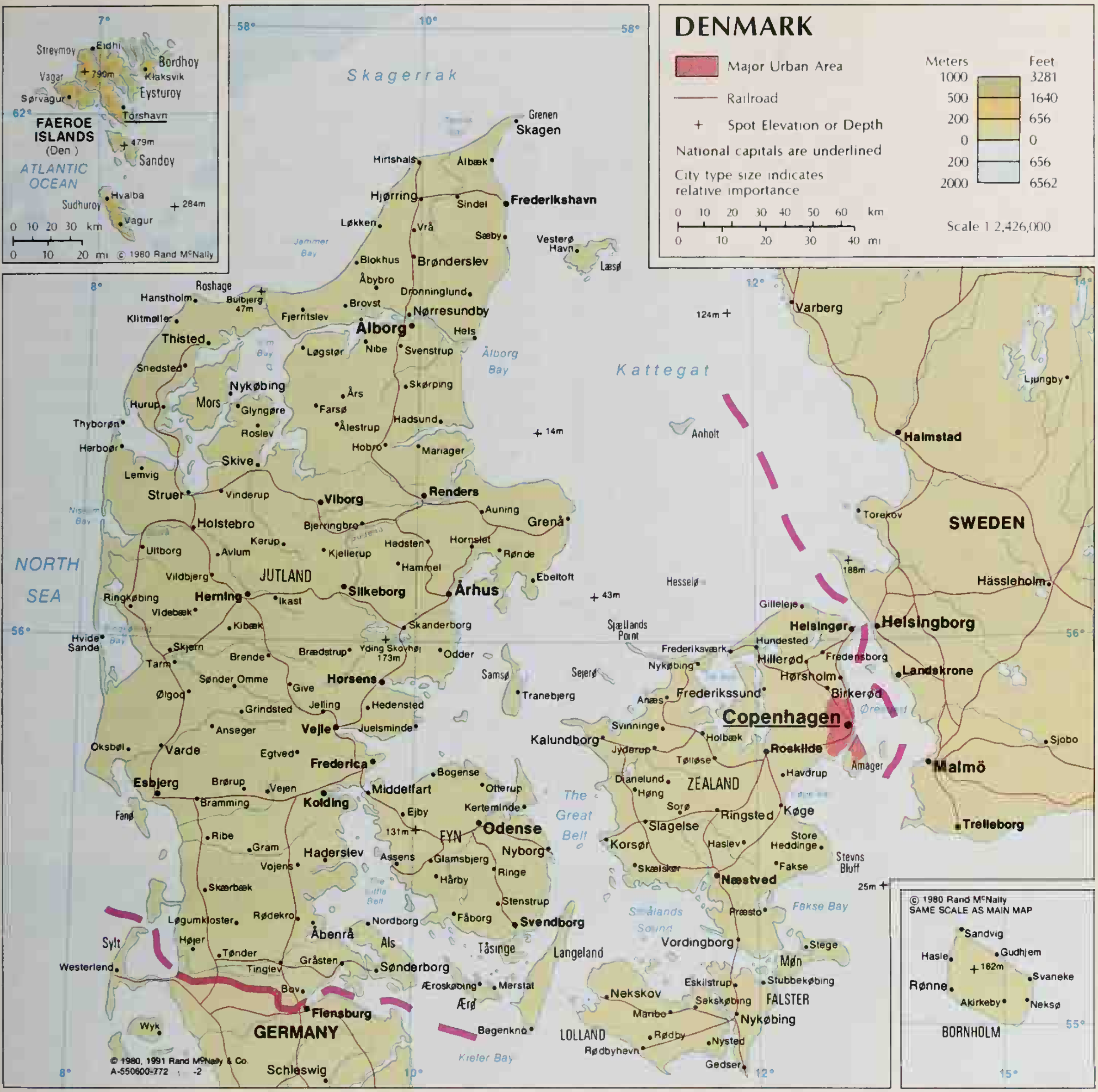
Because of the great extent of cultivation, animal life has changed substantially. At present, Denmark has about 500 species of mammals and more than 300 species of birds.

Resources. Denmark has little mineral wealth, although limestone, clay, and gravel are mined in many areas. In northern Jutland, salt deposits have been exploited since World War II, and granite and kaolin are mined on the island of Bornholm. Since 1972 the Danish sector of the North Sea, called Danfield, has been worked for petroleum and gas deposits.

People

Denmark has an ethnically homogenous population consisting of Nordic Scandinavians. A significant German minority lives primarily in south Jutland. Danish is the official language. Faeroese, spoken in the Faeroe Islands, is a related language. Greenlander, an Eskimo tongue, is spoken in Greenland. The Evangelical Lutheran church (established in 1536) is supported by the state, and about 90% of the population are members. There is complete religious tolerance. The Roman Catholic church, the largest minority, has about 28,000 members.

Demography. Nearly 85% of the population are urban,



with 38% of the total population concentrated in the four largest cities (COPENHAGEN, ÅLBORG, ODENSE, and ÅRHUS). The migration of people from the countryside to cities, which was very pronounced toward the end of the 19th century, has almost ceased. At present, Denmark has a very low population growth rate.

Education and Health. Primary education has been compulsory in Denmark since 1814, and virtually all adults are literate. Comprehensive education, consisting of 9 years in a general school, usually for ages 7 to 16, is provided. Denmark has five universities, at Copenhagen (1479), Ålborg (1974), Århus (1928), Odense (1966), and Roskilde (1970), and numerous technical institutes. Folk High Schools are a special feature of the Danish education system. Originally established during the 19th century, they offer courses primarily in Danish history and culture. They are open to all adults.

Denmark, a pioneer in the development of social welfare programs, long provided free medical care and payments for all workers temporarily unable to work due to illness, injury, or childbirth. By the 1980s, however, there was rising concern about the cost of social programs, which had come to absorb nearly 30% of the national budget. In 1982, social benefits to individuals were partially restricted.

The Arts. Only in the 18th century did a national literature begin, fathered by Ludvig HOLBERG. Bertel THORVALDSEN is the most famous Danish sculptor. The romantic composer C. E. F. Weyse (1774–1847) gave Danish national music its first real expression. Other famous Danish composers include Johann Kuhlau (1786–1832) and Niels W. Gade in the 19th century and Carl NIELSEN in the 20th. The Royal Danish Ballet is internationally renowned. (See also DANISH LITERATURE; SCANDINAVIAN ART AND ARCHITECTURE; SCANDINAVIAN MUSIC.)

Economic Activity

Denmark's prosperity, like that of many small nations, depends on foreign trade. Before 1880 the principal exports were grains, then in demand in rapidly industrializing Germany and the United Kingdom. These markets were lost after the 1870s when cheaper grains from Australia and North America became available, and Denmark switched to a more profitable type of agriculture. Importing grains and growing fodder crops, and feeding both to livestock, Danish entrepreneurs began to export high-value bacon, butter, cheese, eggs, and meat. Industrial development, hitherto slowed in Denmark owing to the lack of raw materials for heavy industry, was aided by the growing demand for equipment in the food-processing industries, and by the end of the 19th century, numerous industrial items were being produced. Industrial development in Denmark has been greatly aided by a well-educated and highly skilled technical labor force. An increasing percentage of the labor force is engaged in service occupations.

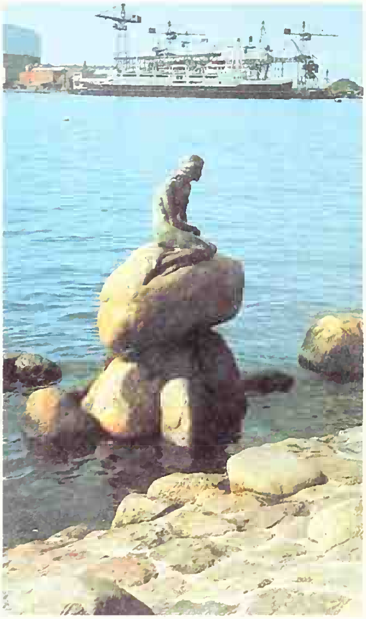
Manufacturing. Approximately 20% of Denmark's labor force are engaged in manufacturing. The leading industry is food processing, which includes the production of Denmark's famous bacon, butter, cheeses, beers, and other items. Most raw materials for other industries are imported and converted in Denmark to consumer and export items, their high value being derived from the technical and artistic skills of the labor force.

Power. Denmark's output of electricity has increased more than tenfold since the 1950s and is derived chiefly from imported petroleum. Following a decision in 1980 not to develop nuclear energy, the Danish government began to focus attention on increasing the pace of exploitation of its North Sea petroleum and natural gas reserves. Most of the fields have been placed under state control, and the government hoped to meet half of the nation's energy needs from North Sea production by the end of the 1980s.

Agriculture. Over 60% of Denmark's land surface is used for agricultural production, but only about 7% of the labor force are engaged in agricultural activities. Barley, grown on about 50% of all farmland, is the principal crop, followed by grass and green fodder, grown on 22% of the land, and root crops, grown on 8% of the land. Most of the barley and root crops are grown primarily for use as livestock feed. About 90% of all farm income is derived from animal products.

Farms in Denmark, mostly family owned, are generally small in size and average around 21 ha (52 acres). Most farmers are affiliated with cooperatives, which were first

(Left) *"Little Mermaid," a bronze sculpture based on a character from a fairy tale by Hans Christian Andersen, is a famous landmark in Copenhagen's harbor. Copenhagen is Denmark's capital, largest city, and most important seaport.* (Right) *Korsør, a center of the fish-processing industry, is located on the southwestern coast of Zealand. Although Denmark's economy is predominantly agricultural, the fishing industry contributes significantly to the nation's wealth.*



introduced in the 1880s and now handle the processing and marketing of farm produce.

Fishing. Fishing employs only a small portion of the work force (0.5%), but it is a major activity in western Jutland. It is also important in the Faeroes and Greenland. The most important fish are sand eels, herring, Norway pout, and cod. The value of fish caught has risen tenfold since 1950, but overfishing has resulted in limitations on fishing practices.

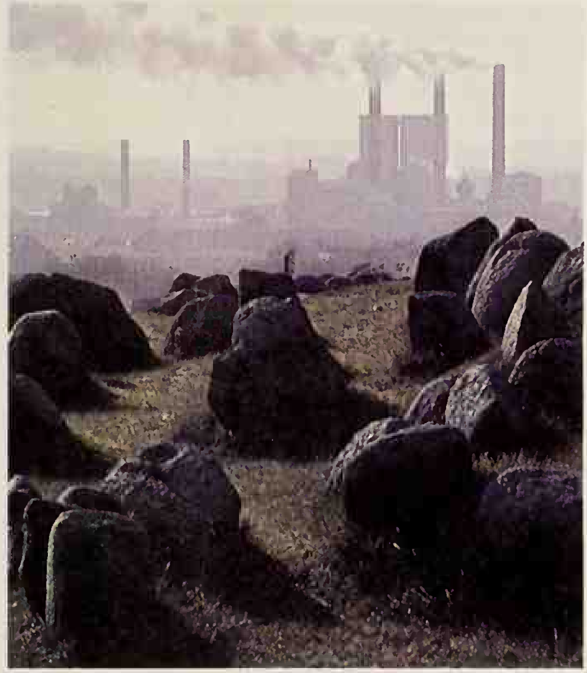
Transportation. Shipping has played an important role in Denmark since the Middle Ages, when tolls were levied on ships passing between the North and Baltic Seas. In 1988, Denmark's merchant marine fleet included 944 vessels of more than 100 metric tons. Although many of Denmark's islands are connected by bridges, ferry traffic between the islands transports about 43 million persons annually and is quick and efficient. The first railway line, from Copenhagen to Roskilde, was opened in 1847. Recently the railways have been modernized, and the number of passengers is increasing after many years of decline. About 70% of the railroads are state owned. The international airport of Copenhagen at Kastrup is the largest in northern Europe. Denmark and the other Scandinavian countries operate SAS (Scandinavian Airlines System).

Foreign Trade. Denmark has been a vigorous supporter of free trade since the 19th century. Today it is a member of the Nordic Council, designed to promote trade within the Scandinavian nations, and, since 1973, of the EUROPEAN COMMUNITY (EC), or Common Market. Agricultural and fish products today account for only about 20% of all exports by value, while industrial goods, the production of which has grown rapidly since the 1950s, now account for about 75% of all exports. Germany and the United Kingdom remain the leading markets for Danish agricultural products, and Sweden is the largest market for industrial products. Denmark's principal imports are petroleum and other fuels, machinery and transportation equipment, metals, and paper and paper products. In the 1970s and up to 1986, imports exceeded exports as a result of Denmark's dependence on imported fuels and raw materials. To offset the deficit in the trade balance the government had to seek loans abroad, but then introduced several restrictive measures and since 1987 exports have exceeded imports.

Government

Denmark is a consititutional monarchy headed by MARGARET II, who became queen in 1972. The revised constitution of 1953 provides for succession to the throne in the female line and for a unicameral legislature, the Folketing. The monarch acts through a cabinet of ministers, headed by a prime minister, responsible to the Folketing. The Folketing has 179 members, elected by a system of proportional representation; two are from Greenland and two are from the Faeroes. The Faeroes have been self-governing since 1948, and in 1979 Greenland attained similar status. The Folketing has a maximum term of four years, but elections are generally called more frequently. Coalition governments have predominated since 1945, the prime minister usually being chosen from the party with the most seats in the Folketing. The principal political parties are the Social Democratic party, the Conservative People's party, the Liberal party, and the Socialist People's party. In 1978 the voting age was lowered from 20 to 18.

Since 1955, Denmark has had an OMBUDSMAN, who oversees the conduct of the cabinet and the decisions of the administration. All citizens have the right to appeal government actions to the ombudsman. Local government is exercised by elected county and municipal councils.



Scattered rune stones mark the site of an ancient Viking burial ground near the modern industrial facilities of Ålborg. One of Denmark's oldest settlements, Ålborg is the capital of Nordjylland County in northern Jutland.

History

Remains from the Stone, Bronze, and Iron ages have been found in Denmark, and rich grave finds from the VIKING period (*c.*800–1050) reveal active Danish participation in Viking explorations. By 878 the Danes had conquered northern and eastern England. In the 11th century King CANUTE (r. 1014–35) ruled over a vast kingdom that included present-day Denmark, England, Norway, southern Sweden, and parts of Finland. Christianity, first introduced in 826, became widespread during Canute's reign.

During the 13th century, Waldemar II (r. 1202–41) conquered present-day SCHLESWIG-HOLSTEIN, Pomerania, Mecklenberg, and Estonia and reestablished the nation as a great power in northern Europe. Soon, however, a civil war between the nobles and the king vying for control of the country erupted. Christopher II (r. 1320–32) was forced to make major concessions to the nobles and clergy at the expense of royal power, which was also eroded by the influence of the German merchants of the Hanseatic League. Waldemar IV (r. 1340–75) succeeded in restoring royal authority, however, and his daughter Margaret I (r. 1387–1412) created the Kalmar Union, which included Denmark, Norway, Sweden, the Faeroe Islands, Iceland, Greenland, and part of Finland. In 1520, Sweden and Finland revolted, seceding in 1523, but the union continued until 1814.

In 1448 the house of Oldenburg was established on the throne in the person of Christian I. During the reign (1534–59) of Christian III, the Reformation brought about the establishment of a national Lutheran church. In the following century Christian IV intervened in the Thirty Years' War (1618–48) as a champion of Protestantism. A series of wars with Sweden resulted in territorial losses, but the Great Northern War (1700–21) brought some restoration of Danish power in the Baltic. The 18th-century internal reform included the abolition of serfdom and land reforms.

In 1814, Denmark, which had sided with Napoleonic France after British attacks on Copenhagen in 1801 and 1807, was forced to cede Norway to Sweden and Helgoland to England. In 1848, a Prussian-inspired revolt in Schleswig-Holstein ended without a victor, but in 1864, Schleswig-Holstein and Lauenburg were lost in a new war with Prussia. Despite these territorial losses, Denmark prospered in the 19th century. In 1849, King Frederick VII (1848–63) authorized a new constitution instituting a representative form of government.

Intensive cultivation of the Danish island of Fyn produced this quilt-like pattern of fields. Fyn, Denmark's second-largest island (excluding the dependency of Greenland), is located in the Baltic Sea.

Commercial fishing vessels line the wharves of Ærøsksøbing, a small village on the northern coast of Ærø, one of Denmark's more than 600 islands. Fishing has become one of Denmark's most important industries.

During World War I, Denmark maintained neutrality. At the war's end, North Schleswig returned to Denmark following a plebiscite, and the present southern border with Germany was established. In 1933 great social reforms were instituted, beginning Denmark's modern welfare state.

At the beginning of World War II, despite a declaration of neutrality, Denmark was occupied by Germany (Apr. 9, 1940). On May 5, 1945, the Germans capitulated, and the country was liberated. Iceland had become fully independent in 1944. In 1973, Denmark became a member of the EC (European Community). Under its Conservative premier, Poul Schlüter, Denmark in the 1980s with some difficulty sought to preserve its distinctive Nordic character while integrating itself into the new Europe.

denouement see NARRATIVE AND DRAMATIC DEVICES

density Density, in physics, denotes the ratio of the mass of a substance to its volume, expressed in grams per cubic centimeter or pounds per cubic foot. The ratio of the density of a substance to that of water is called the SPECIFIC GRAVITY of that substance. The term *density* is also

DENSITY OF VARIOUS LIQUIDS AND SOLIDS

Material	*Grams per cm^3*	*Pounds per ft^3*	*Temp °C*
Liquids			
Alcohol, ethyl	0.791	49.4	20
Carbon tetrachloride	1.595	99.6	20
Gasoline	0.66–0.69	41.0–43.0	
Mercury	13.6	849.0	
Water	1.00	62.43	4
Solids			
Brick	1.4–2.2	87–137	
Cork	0.22–0.26	14–16	
Diamond	3.01–3.52	188–220	
Ice	0.917	57.2	
Oak	0.60–0.90	37–56	

used in many non-technical ratios, such as population density.

density current A density current is a gravity-induced flow within liquid or gas arising from horizontal or vertical differences in density. Turbidity currents, which pour down submarine canyons, are a special type of underwater density current in which excess density is caused by a heavy load of suspended sediment.

Circulation in the ocean depths, far below wind-driven ocean currents, is caused mainly by density currents. These currents arise from differences in temperature and salinity, with low temperature and high salinity both resulting in increased density. The distinct density layering of vertical columns of seawater is established and maintained by density currents. One such current carries cold, highly saline water from the Weddell Sea down to the ocean floor in winter and, after circulating around Antarctica, mixes it with other water masses so it slowly flows northward into the deepest parts of all three major ocean basins.

dentistry Dentistry is the branch of medicine concerned with preventing, diagnosing, and treating diseases of the teeth and adjacent oral structures and restoring missing teeth and oral structures. One who practices dentistry is called a dentist and must have a thorough knowledge of the structure, origin, growth, function, and diseases of the mouth, as well as of medical, surgical, and mechanical treatment. The dentist must also understand the relationship of the mouth to other parts of the body and how general body diseases may be reflected by disorders in the mouth.

Major Health Problem

Diseases of the teeth and surrounding parts of the mouth constitute a major health problem. Some estimates indicate that in the United States, for example, almost 29 million people have lost all their natural teeth. Tooth decay is most prevalent during childhood and adolescence. About half of all 2-year-old children have at least one decaying tooth. At the age of 16, the average person has seven decayed, filled, or missing teeth. Approximately one person out of three over the age of 35 needs dentures, or artificial teeth. More than 50 percent of adults over the age of 40 have one or more teeth missing due to periodontal, or gum, disease, which affects 67 million Americans.

Few patients die as a direct result of dental disease, but considerable suffering is directly attributed to bad teeth and diseased gums. Rampant dental caries, or cavities, in children result in facial deformities in adulthood and may contribute to bacterial contamination of the blood, or bacteremia. Bacteremia, in turn, may contribute to the development of bacterial endocarditis, which is a bacterial infection of the tissue lining the heart. Eliminating decayed teeth in children is urgent in the treatment of rheumatic fever, in order to prevent infection of a heart valve.

Deaths from cancer of the mouth account for more than 5 percent of all deaths due to cancer. For the adult, therefore, periodic dental examinations may be lifesaving. Similarly, periodic examinations may prevent osteomyelitis, a serious infection of bone, probably caused by certain forms of dental infection.

Despite the evidence cited above, studies by the World Health Organization indicate that tooth decay is decreasing in technologically advanced countries. This progress is believed to be the result of preventive dentistry, improved methods of dental care, improved diet, and the increased number of communities fortifying their water supplies with fluorides (see fluoridation). Many studies have proved that fluoridated water ingested during childhood significantly reduced the number of cavities in later years.

History

People have written about and tried to treat dental problems for more than 4,000 years. Ancient Egyptians had "physicians of the teeth" and "toothmakers." Pyorrhea

This 16th-century woodcut is a copy of the painting by the northern Renaissance artist Lucas van Leyden. While the well-dressed "surgeon" operates on the peasant's teeth, his assistant robs the patient of his money.

was treated in ancient Rome. In ancient Greece infants were drugged during teething, and bleeding gums were cauterized with hot irons.

Arabian physicians during the Middle Ages developed the use of dentifrices and metallic fillings. Abulcasis, an Arabian dental surgeon, developed instruments for cleaning the teeth and gums, though the modern toothbrush was not invented until 1498, by a Chinese dentist.

From the Middle Ages until the early 1700s, barbers in England and France traditionally practiced a form of dentistry. This tradition was carried to America, where frontier barbers commonly practiced dentistry. The red-and-white barber pole symbolized, as well as advertised, their practice.

French surgeon Pierre Fauchard (1678–1761) is considered the father of modern dentistry. His treatise (1728) described the symptoms and treatment of oral disease; improved instruments for filling and extracting teeth; and upper and lower dentures, as a complete set, connected with springs.

In the 1700s artificial teeth were made from wood, ivory, and gold. Replantation and transplantation were also popular. Replantation is replacement of a tooth by moving one of the patient's normal teeth to the empty socket; transplantation is replacement with a tooth from another person.

John Greenwood, who extracted the last remaining tooth of George Washington in 1789 and constructed the president's dentures, is credited with developing the foot-operated dental drill.

The first dental school in the United States, the Baltimore College of Surgery, opened in 1840. A medical and dental milestone was the use of nitrous oxide (laughing gas) to produce general anesthesia. The American dentist Horace Wells began using it in 1844. Several years later William Morton demonstrated the use of ether as an anesthetic.

Dentistry was organized in its modern form between 1870 and 1900. In this turn-of-the-century photograph, a small-town dentist uses an early drill to repair a patient's tooth.

Germs and Tooth Decay

During the late 1800s the new theory that disease was caused by "germs" influenced the modern concept that bacteria cause tooth decay and gum disease. Gum disease and cavities were finally proved by the early 1960s to have a common origin: a tenacious deposit on the teeth called *dental plaque*, which is debris that harbors colonies of bacteria and bacterial products. Cavities appear to form when sugar in the diet enters the plaque and is broken down bacterially into acids, which eventually erode the protective enamel on the tooth surface. Plaque may also lead to gum disease and to the loss of teeth even without cavities. The process is initiated when plaque irritates the gum and underlying bone and loosens a tooth in its socket. Gum and bone recede, and pus forms in pockets between the gum and the tooth; the tooth becomes wobbly and is eventually lost from lack of support.

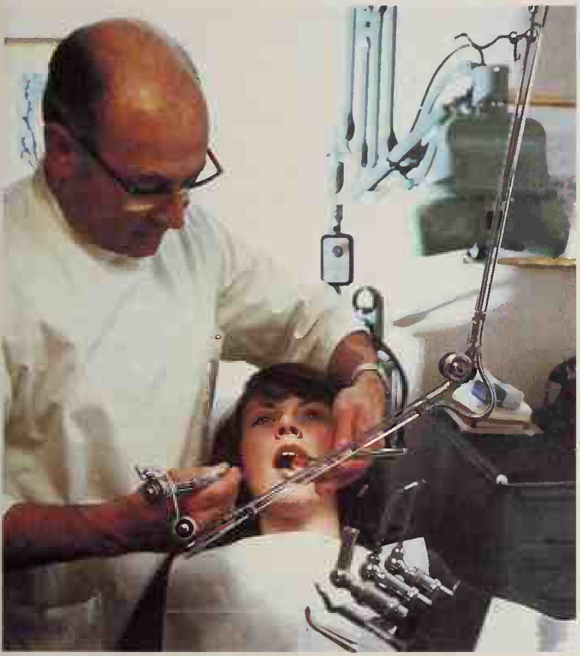
Modern Dental Practice

Tremendous improvements have been made in the efficiency of dental service. For example, drills used to rotate at a top speed of 5,000 revolutions per minute, often causing discomfort through vibration, pressure, and heat. Modern drills can rotate at speeds of up to 300,000 revolutions per minute, eliminating the sense of vibration and the need for more than very light pressure. A spray of water is also directed at the drilled area, keeping temperatures low.

Medication. Antibiotics prevent or eliminate dental infections that were once quite difficult to manage. ANESTHETICS are used to prevent pain. Local anesthetics are the most common. Only the areas of the mouth into which they are injected are made numb, and the patient remains conscious. Sometimes general anesthetics are used, rendering the patient unconscious and completely insensitive to pain.

Fillings. Materials used for restoring or filling teeth include gold, silver, synthetic porcelain, and acrylic resins. The gold inlay is based on a precision casting process. The prepared cavity is filled with softened wax, which is then carved to the proper shape. A mold is made of the wax pattern, the wax is eliminated, and the molten gold is cast in the empty mold. The inlay is then sealed into the tooth with cement. The silver filling is actually a soft amalgam of silver, tin, and mercury. When packed into a cavity it hardens in a short time, but before doing so it can be carved to the desired contour. Porcelain fillings have a natural appearance but are comparatively fragile and have a tendency to wash away. Acrylic resins are used to make DENTURES: they have a lifelike appearance for gum replacement, and their density reduces fluid absorption and odors. Gold, porcelain, and acrylic are used to make artificial crowns, or caps, fitted over deformed teeth.

Sealants. The application of protective plastic resins to children's chewing teeth has been gaining wide acceptance. The teeth are first etched by a phosphoric acid



Having examined the teeth of his patient, a dentist prepares to drill a cavity. Modern technology has helped to eliminate the discomfort of this procedure. It has also provided durable filling materials, local anesthetics, and X-ray photography.

solution to create a porous surface into which the sealant can penetrate more easily. Tests have shown that the treatment is effective in preventing the development of cavities.

Dental Education

The approved dental schools in the United States are usually branches of large universities. The dental school course takes four years to complete, and the student earns the degree of Doctor of Dental Surgery (D.D.S.). The person must then pass an examination given by a state board before being given a license to practice.

Specialty fields include oral surgery, ORTHODONTICS, PERIODONTICS, pedodontics, and prosthodontics. Oral surgery includes procedures from tooth extraction to major surgery for tumors of the mouth or jaw, for fractures and dislocations of the face and jawbones, and for repair of cleft lip (hairlip) and cleft palate. Orthodontics includes the prevention and correction of misaligned teeth, improper meshing of the upper and lower teeth, and the associated facial deformities and speech problems. Diseases of the gums and supporting structures of the teeth are treated by a specialist in periodontics. Pedodontics deals with the dental care of children. Prosthodontics, or prosthetic dentistry, involves the making of dentures or other artificial replacements.

dentures Dentures are artificial replacements for missing teeth and supporting tissues. Dentures restore facial appearance and the ability to speak clearly and to chew food by maintaining the natural shape of the jaw. The specialty of dentistry involving construction of dentures is known as prosthodontics.

Until the 19th century, dentures were crafted of such materials as stone, wood, and animals' teeth. Then techniques were developed to embed artificial teeth in gutta-percha or rubber bases. Following World War II, plastic materials have been used to hold porcelain or plastic teeth.

In constructing modern dentures, a dentist makes an impression of the jaw ridges and fills it with a dental plaster, which forms a duplicate of the ridges. The denture is made from the plaster image, and artificial teeth are set in a way to ensure proper bite and facial contour. When all the teeth in either jaw are missing, a complete denture is used. It is usually held in place by suction created between the saliva and the tissues of the mouth. A partial denture is used when some of the teeth are missing. It is held in place by metal clasps that attach to natural teeth. A fixed partial denture, or bridge, is often attached to adjacent teeth permanently.

In a dental implant, false teeth are attached to blades or screws that are fixed into the jawbone, or a metal frame may be fitted under the gum if the bone itself has deteriorated too extensively to provide support. Such procedures are considered controversial by many dentists, however, because they may cause bone-loss or infection problems.

Denver The capital of Colorado and an economic center of the Great Plains and Rocky Mountain regions, Denver is located on the South Platte River in the north central part of the state. The city, with an area of 275 km^2 (106 mi^2), is coextensive with Denver County. Denver has a population of 467,610 (1990), with a metropolitan-area population of 1,622,980.

Denver is situated at an elevation of about one mile above sea level, a fact reflected in its nickname, "Mile High City." The Front Range of the Southern Rockies rises abruptly to heights of more than 4,265 m (14,000 ft) nearby to the west, but Denver itself sprawls over an unimpressive prairie landscape. Despite a semiarid climate (annual precipitation is 405 mm/16 in) and relatively steady winds, considerable smog is generated locally.

The economy is diversified, with commerce, particularly sales and distribution, of primary importance. Although the city is not a major tourist resort, Denver is the gateway to the various attractions of the nearby mountains. The city also has regional federal offices and rapidly growing industries, including aerospace; rubber; energy; and food processing associated with the stockyards. A branch of the U.S. Mint (1906) is located there, as well as a number of military installations.

Denver is the home of the University of Colorado Medical Center and the University of Denver (1864). Other cultural institutions include the Colorado State Historical Museum, the Denver Art Museum, the Buffalo Bill Cody Memorial Museum (at Lookout Mountain), and a center for the performing arts. In addition, Denver has an exten-

The skyline of Denver, capital of Colorado, attests to the city's position as the commercial, industrial, and cultural center of the Mountain states.

sive system of public parks covering 1,740 ha (4,300 acres) in the city and 5,500 ha (13,600 acres) in the foothills of the Front Range.

Originally consolidated (1860) from two small mining camps, Denver, which was named for James W. Denver, governor of Kansas Territory in 1858, was designated capital of the Colorado Territory in 1867. The coming of the railroads in 1870 and a subsequent silver-mining boom in the mountains stimulated population growth, from 5,000 in 1870 to 107,000 in 1890. Denver has since emerged as the main urban center between the Minneapolis–Kansas City–Dallas axis and the Pacific Coast.

deodar see CEDAR

deodorizer Substances used to eliminate, chemically change, or mask an odor, deodorizers act by absorbing odorous molecules, by dissolving or emulsifying them, or by killing the bacteria that cause odors. Certain highly porous substances—the clay fuller's earth, activated charcoal, or silica gel—are commonly used in air filters to remove odor. In the process called scrubbing, odorous gases are forced through water or a chemical solution, and their odor-causing molecules are dissolved or emulsified. Deodorizers sprayed into the air react with odors in this way. Antiseptic deodorizers such as chlorine, hydrogen peroxide, and iodine eliminate odor-causing microorganisms. Body deodorants and antiperspirants use zinc or aluminum salts in alcohol as deodorizers and astringents. The use of hexachlorophene, a powerful germicide once widely used in deodorants, is now restricted by law because laboratory tests indicated it could cause damage to the nervous system. Other so-called deodorizers, like perfume, are used in an attempt to mask unpleasant odors with stronger odors.

department store Department stores sell a wide variety of goods, each type being housed and merchandised in a separate department. About 1865, Bon Marché became the first true department store. Built in the center of Paris, it was splendidly furnished and decorated, catering with style to the rich and the prosperous middle class. Chicago's Marshall Field (1865) and Boston's Filene's (1881) were other early department stores. Selfridge's, London's first "modern" department store (1909), was patterned after Marshall Field. In the 1920s, J. C. Penney began the first department store chain. Suburban growth after World War II saw the gradual abandonment of U.S. center-city stores and their spread into the suburbs. About the same time, the discount house, a department store stripped of the usual amenities but selling goods at reduced prices, became a fixture on the RETAILING scene.

deportation In current usage deportation is the expulsion of ALIENS from a country in which they are living, usually because they have entered illegally, are criminals, or are considered undesirable for some other reason.

In the United States, where deportation is the responsibility of the Immigration and Naturalization Service of the Department of Justice, the majority of deportees are aliens who have entered the country illegally. Some countries, however, have deported well-established minority groups—for example, the Asians in East Africa.

In the past, deportation referred primarily to the practice of banishing criminals. Britain deported many thousands of convicts to its colonies in North America, the West Indies, and Australia, a practice that ended in the 1850s. In tsarist Russia, criminals and political offenders were deported to Siberia, a practice later revived by the Communist regime under Joseph Stalin. During World War II the Germans deported millions of people from the countries they occupied to forced-labor camps in Germany.

deposition A deposition is the testimony of a witness under oath taken outside of court and written down to be introduced later at a trial or other judicial proceeding. The opposing party must have an opportunity to cross-examine the witness at the time the deposition is being taken. In some of the United States, permission to take depositions must be secured from the court, but in other jurisdictions they may be taken upon reasonable notice to the adverse party. Generally, depositions can be introduced as evidence in court only if the witness is unavailable to testify in person.

depression Depression is an uncomfortable mental state that may be characterized by such adjectives as *blue, dejected*, or *discouraged*. In ordinary usage the word refers to a mood state that in medicine is called dysthemia, as contrasted with the normal state of euthymia and the opposite state of elation. In psychiatric usage, disorders of mood are called affective disorders; depression can be such a disease in itself or a symptom of another mental disorder. Normal human responses to some situations may also include transient depressions; for example, mourning is usually accompanied by a depressed mood, but this is not considered to be anything other than an expected response to loss.

Major depressions occur in 10% to 20% of the world's population in the course of a lifetime. Women are more often affected than men, by a two to one ratio, and they seem to be at particular risk in the period prior to menstruation or following childbirth. Relatives of patients with major depression also seem to be at some higher risk of becoming depressed, and about 2% of the population may have a chronic disorder known as a depressive personality.

Characteristics. The symptoms of depression are: (1) poor appetite and significant weight loss, or increased appetite and significant weight gain; (2) insomnia, or increased sleep; (3) agitation, or retardation, of movement and thought; (4) loss of interest or pleasure in usual activities or decrease in sexual drive; (5) fatigue and loss of energy; (6) feelings of worthlessness, self-reproach, or excessive or inappropriate guilt; (7) diminished ability to think or concentrate, or indecisiveness; and (8) recurrent thoughts of death or suicide, or suicide attempts.

Not all of these characteristics occur in each individual who becomes depressed, and some or all may be present and the individual may still not consider himself or herself to be depressed. A person is considered to have experienced a major depressive episode if he or she exhibits a loss of interest in almost all usual activities and shows at least four of the above symptoms for two weeks.

Causation. Depressions are often reactions to some loss of or separation from a valued person or object. These are called reactive depressions (or, sometimes, neurotic depressions, but that term is a misnomer), as contrasted with the usually more severe depressions without apparent cause called endogenous depressions, or those accompanied by delusions or hallucinations and sometimes called psychotic depressions. (*Melancholia*, a term once used to describe all depressive states, is now applied only to these most severe forms of depression.)

The predominant chemical, or biological, theory of depression is the so-called amine hypothesis. Based on observations that depression can be caused by drugs that deplete the brain of chemicals called biogenic amines, the hypothesis suggests that depressions are caused by a decrease in amines such as norepinephrine (noradrenaline) and serotonin in specific brain areas (see HORMONE, ANIMAL). In fact most (but not all) effective ANTIDEPRESSANT drugs can increase the amounts of amines in the brain by blocking their breakdown or exit from the body; despite the attractiveness of the theory, however, the exact nature of the presumed chemical lesion in the brain has yet to be defined even after many years of research.

Psychological theories of the cause of major depression remain equally unproven, however, and clear familial associations of depressive illness—along with the responsiveness of the state to drugs—do indicate that depression has some biological substrate. Most modern theorists would agree that both biological and psychological factors play a role.

Treatment. Depression is treated by PSYCHOTHERAPY, drugs, or electroconvulsive SHOCK THERAPY (ECT), and often by some combination of these treatments. In recent years several experimental drugs have been introduced, but on the whole they seem to offer no particular advantage over standard treatments. Most depressions are self-limited, but selected treatment with modern therapies can shorten the duration of the disease by many months. Treatment and hospitalization may prevent suicide attempts, as well.

Certain well-defined methods of psychotherapy can help in the treatment of some cases of depression, but no evidence exists that traditional insight-oriented psychoanalytic therapy is effective in serious cases, such as those accompanied by suicidal thoughts or attempts. Psychiatric hospitalization is often necessary in such cases, which are usually treated by drug therapy.

Two major classes of antidepressant drugs are effectively used: the tricyclic drugs, employed since the early 1960s, and the monamine oxidase inhibitors. The tricyclics are effective in about 75% of depressed patients. Their exact mechanism of action is unknown, but it is believed to involve their effect on the disposition of norepinephrine or serotonin in the brain. These drugs are not stimulants—in fact they often cause sleepiness. Sleep disorders may diminish after two or three weeks.

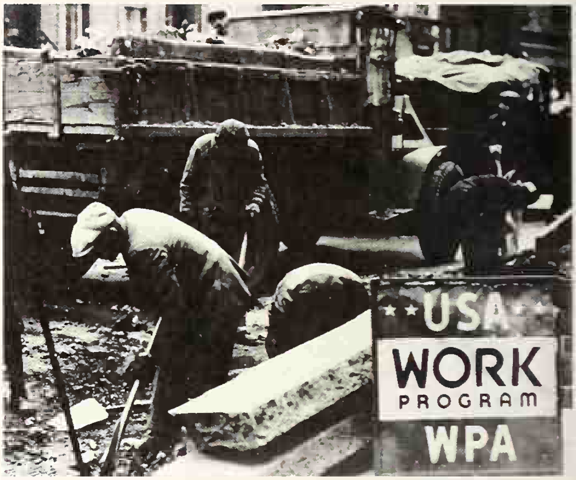
The other major antidepressant drugs, the monamine oxidase inhibitors, prevent the formation of monamine oxidase, an enzyme that breaks down biogenic amines in the brain and intestinal tract, so their effectiveness is attributed to normalizing the amount of amine in the brain. Because the enzyme ordinarily breaks down food amines that would otherwise cause an increase in blood pressure, however, the body is no longer protected from this effect when the drugs are used. Patients who are given the drugs must therefore control their diets accordingly. The drugs can also interact with many other drugs to cause increases in blood pressure.

In depressions sufficiently severe to require psychiatric treatment, ECT has been found an effective short-term procedure. It has been misused and overused so widely, however, that a public aversion to it exists, and ECT is now most often used in cases of severe endogenous and delusionary depressions. Important short-term side effects of ECT include confusion and memory loss.

Depression of the 1930s The economic depression that beset the United States and other countries in the 1930s was unique in its magnitude and its consequences. At the depth of the depression, in 1933, one American worker in every four was out of a job. The great industrial slump continued throughout the 1930s, shaking the foundations of Western capitalism and the society based on it.

Economic Aspects. President Calvin Coolidge had said during the long prosperity of the 1920s that "The business of America is business." Despite the seeming business prosperity of the 1920s, however, there were serious economic weak spots, a chief one being a depression in the agricultural sector. Also depressed were such industries as coal mining, railroads, and textiles. Throughout the 1920s, U.S. banks had failed—an average of 600 a year—as had thousands of other business firms. By 1928 the construction boom was over. The spectacular rise in prices on the STOCK MARKET from 1924 to 1929 bore little relation to actual economic conditions. In fact, the boom in the stock market and in real estate, along with the expansion in credit (created, in part, by low-paid workers buying on credit) and high profits for a few industries, concealed basic problems. Thus the U.S. stock-market crash that occurred in October 1929, with huge losses, was not the fundamental cause of the Great Depression, although the crash sparked, and certainly marked the beginning of, the most traumatic economic period of modern times.

By 1930 the slump was apparent, but few people expected it to continue; previous financial PANICS and depressions had reversed in a year or two. The usual forces of economic expansion had vanished, however. Technology had eliminated more industrial jobs than it created; the supply of goods continued to exceed demand; the world market system was basically unsound. The high tariffs of the Smoot-Hawley Act (1930) exacerbated the downturn. As business failures increased and unemployment soared—and as people with dwindling incomes nonetheless had to pay their creditors—it was apparent that the United States was in the grip of economic breakdown. (Most European countries were hit even harder, because they had not yet fully recovered from the ravages of World War I.)



The Works Progress Administration (WPA) was a New Deal program to provide employment for America's jobless. Between 1935 and 1942 the WPA employed an average of 2.1 million persons and injected more than $11 billion into the U.S. economy.

This poster by Ben Shahn was commissioned by the U.S. government to advertise the services offered by the Resettlement Administration, a federal agency formed to aid impoverished farmers during the Depression.

The deepening depression essentially coincided with the term in office (1929–33) of President Herbert Hoover. The stark statistics scarcely convey the distress of the millions who lost jobs, savings, and homes. From 1930 to 1933 industrial stocks lost 80% of their value. The gross national product (GNP), which for years had grown at an average annual rate of 3.5%, declined at a rate of over 10% annually, on average, from 1929 to 1932. Agricultural distress was intense: farm prices fell by 53% from 1929 to 1932.

President Hoover opposed government intervention to ease the mounting economic distress. His one major action, creation (1932) of the Reconstruction Finance Corporation to lend money to ailing corporations, was seen as inadequate. Hoover lost the 1932 election to Franklin D. Roosevelt.

The New Deal. The depression brought a deflation not only of incomes but of hope. In his first inaugural address (March 1933), President Roosevelt declared that "the only thing we have to fear is fear itself." But though his New Deal grappled with economic problems throughout his first two terms, it had no consistent policy.

At first Roosevelt tried to stimulate the economy through the National Recovery Administration, charged with establishing minimum wages and codes of fair competition. It was intended to stabilize production and prevent the price slashing that had begun after 1929. This approach was abandoned after the Supreme Court declared the NRA unconstitutional in Schecter Poultry Corporation v. United States (1935).

Other innovations of the Roosevelt administrations had long-lasting effects, both economically and politically. To aid people who could find no work, the New Deal extended federal relief on a vast scale. The CIVILIAN CONSERVATION CORPS took young men off the streets and sent them out to plant forests and drain swamps. The government refinanced about one-fifth of farm mortgages through the FARM CREDIT ADMINISTRATION and about one-sixth of home mortgages through the Home Owners Loan Corporation. The WORKS PROGRESS ADMINISTRATION employed an average of over 2 million people in occupations ranging from laborers to musicians and writers. The PUBLIC WORKS ADMINISTRATION spent about $4 billion on the construction of highways and public buildings in the years 1933–39.

The depression years saw a burst of union organizing, aided by the NATIONAL LABOR RELATIONS ACT of 1935. New industrial unions came into existence through the efforts of organizers led by John L. LEWIS, Walter REUTHER, Philip Murray, and others; in 1937 they won contracts in the steel and auto industries. Total union membership rose from about 3 million in 1932 to over 10 million in 1941.

Political and Cultural Effects. The expanded role of the federal government came to be accepted by most Americans by the end of the 1930s. Even Republicans who had bitterly opposed the New Deal shifted their stance. Wendell WILLKIE, the Republican presidential nominee in 1940, declared that he could not oppose reforms such as the regulation of the securities markets and the utility holding companies, the legal recognition of unions, or Social Security and unemployment allowances. What bothered him and other critics, however, was the extension of the federal bureaucracy.

The depression caused much questioning of inherited economic and political ideas. Sen. Huey P. Long (see LONG family) of Louisiana found a national following for his "Share the Wealth" program. The socialist writer Upton SINCLAIR was nearly elected governor of California in 1934 with a similar program for redistributing the state's wealth.

In other countries the depression had even more profound effects. As world trade fell off, countries turned to nationalist economic policies that only exacerbated their difficulties. In politics the depression strengthened the extremes of right and left, helping Adolf HITLER to power in Germany and swelling left-wing movements in other European countries. The depression was thus a time of massive insecurity among peoples and governments, contributing to the tensions that produced World War II. Ironically, however, the massive military expenditures for that war provided the economic stimulus that finally ended the depression.

depth charge Depth charges are explosive antisubmarine munitions either fired or dropped into the water from ships or aircraft and fused to detonate upon reaching a preset depth. The shock waves from an underwater explosion are transmitted with great force for considerable distances, and a direct hit is not required to crush the hull or rupture the seams of a submarine.

Depth charges consist of a casing, an explosive filler, and one or more detonating devices. Designed to sink rapidly, depth charges are fitted with a hydrostatic fuse, which senses water pressure and detonates upon reaching a depth setting selected prior to firing to correspond to the estimated target depth. The term *depth charge* is loosely applied to all free-falling antisubmarine munitions, including magnetically and contact-fused devices that are not true depth charges.

depth of field The depth of field in a photograph is the range of distances from the CAMERA over which focus is considered adequately sharp. Perfect focus is achieved in one plane only, and the acceptable field extends for some distance on the near and far sides of this plane. The depth of field will be small when the focused object is near the camera and when the LENS diameter is large, as, for example, when a lens of long focal length is used at wide aperture. Conversely, a camera having a lens of short focal length stopped down to a narrow aperture will give a considerable depth of field.

depth perception see PERCEPTION

Derain, André [duh-ran'] André Louis Derain, b. June 17, 1880, d. Sept. 8, 1954, was part of the original group of French painters to work in the early modernist style known as FAUVISM. As an art student in Paris, Derain first came to prominence in 1905, when he, together with Henri Matisse, Maurice de Vlaminck, and others, exhibited at the Salon d'Automne. The critic Louis Vauxcelles, offended by their use of brilliant, pure colors and spontaneous execution, called them *les fauves* ("wild beasts"). Derain's Fauvist works typically display bright patches of color and bold, asymmetrical compositions, as in *Westminster Bridge* (1907; private collection, Paris).

Westminster Bridge *(1907) is an early work by André Derain, whose use of vibrant color and dynamic forms illustrate his contribution to Fauvism, the first revolutionary movement in early-20th-century painting. (Private collection, Paris.)*

Toward the end of 1907, Derain abandoned Fauvism and, like his new friends Pablo Picasso and Georges Braque, turned to Paul Cézanne for inspiration. Derain, however, never fully adopted the cubist style forged by these other artists from 1908 on. By 1918, Derain had repudiated both cubism and the new abstract art in favor of a more traditional approach to the construction of solid forms, based on the example of the old masters. From the 1920s on, a strong classical influence is evident in Derain's paintings and drawings and in the stage designs he produced for the Ballets Russes de Serge Diaghilev and other companies.

Derby [dahr'-bee] Derby is an industrial center and the county town of Derbyshire in north central England. It is situated on the River Derwent about 50 km (30 mi) northeast of Birmingham. The population is 215,400 (1988 est.). Airplane parts, chemicals, textiles, and the well-known Derby porcelain are manufactured there. Historical landmarks include the Cathedral of All Saints (begun 1509), with its perpendicular-style tower.

Derby was first established as the Anglo-Saxon town of Northwothige. In 1719, England's first successful silk mill opened there, and in 1750 porcelain manufacturing began. With the arrival of the railroad in the 19th century, Derby grew rapidly into an important industrial and railroad center.

Derby, The [dahr'-bee] The Derby, also known as the Derby Stakes or the English Derby, is one of horse racing's most prominent races and is certainly the most famous in England. The race dates back to 1780, when it was founded and named for the 12th earl of Derby. Limited to 3-year-old colts and fillies, the race is run on a 1.5-mi (2.4-km) course at Epsom Downs on the last Wednesday of May or the first Wednesday of June each year. Colts carry 57 kg (126 lb) and fillies 55 kg (121 lb) in this legendary race, which has been won only 6 times by fillies, the last time in 1916.

Derby, Edward Stanley, 14th Earl of [dahr'-bee] Edward George Geoffrey Smith Stanley, 14th earl of Derby, b. Mar. 29, 1799, d. Oct. 23, 1869, was prime minister of Great Britain three times (1852, 1858–59, 1866–68) and leader of the Conservatives for 22 years (1846–68). As secretary for Ireland (1830–33) and then for the colonies (1833–34), he secured passage of Ireland's first national education act in 1832 and the abolition of slavery in 1833. While prime minister, Lord Derby abolished legal restrictions on Jews and transferred the government of India from the East India Company to the crown in 1858. He also put through the 1867 Reform Act, calling this widening of the franchise a "leap in the dark." Although a fine speaker in Parliament, and despite his achievements, Derby was overshadowed by his lieutenant Benjamin DISRAELI, who succeeded him as prime minister.

Derbyshire [dahr'-bee-shir] Derbyshire is a county in the northern Midlands of Central England. The population of Derbyshire is 924,200 (1988 est.), and the county covers an area of 2,631 km^2 (1,016 mi^2). DERBY is the county town. Southern Derbyshire is a lowland drained by the River TRENT. The elevation increases to the north, where the High Peak portion of the PENNINES is included in Peak District National Park. Coal is mined in the east, where most of the county's manufacturing takes place; major industries include steel, chemicals, engineering, paper, and textiles. Dairy cattle are raised in the county's lowlands.

Derby was settled by Romans, who mined lead in the area. Later it became part of the Anglo-Saxon kingdom of Mercia. Its textile industry, developed during the mid-18th century, made Derbyshire one of Britain's early industrial centers.

derivative see CALCULUS; DIFFERENTIAL CALCULUS

Dermaptera see EARWIG

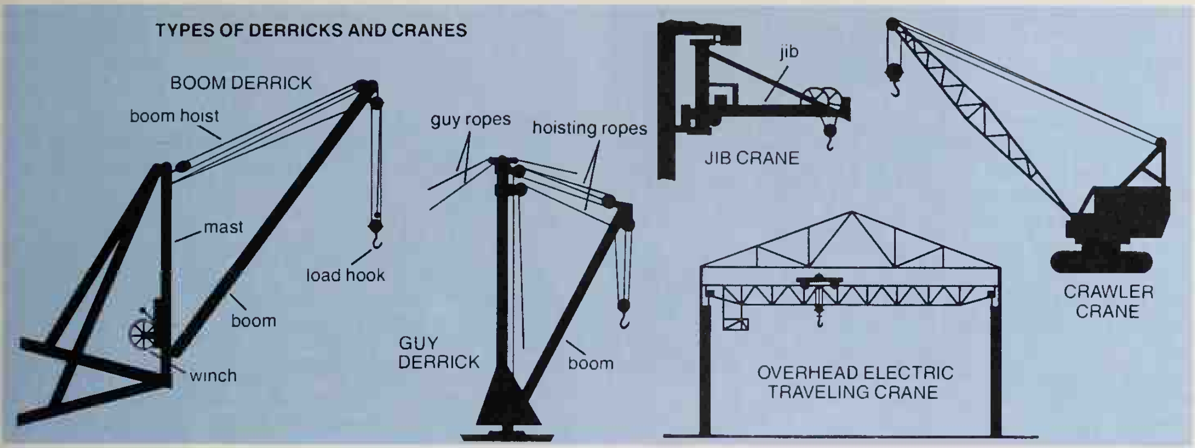
dermatitis [dur-muh-ty'-tis] Dermatitis is an inflammation, or irritation, of the skin resulting from such causes as bacteria, fungi, parasites, and foreign substances called allergens. It can arise directly from skin contact with external agents or as a result of disorders elsewhere in the body. The symptoms of dermatitis include itching, burning, redness, blistering, and EDEMA (swelling). Scratching may result in secondary bacterial infection.

Skin-contact dermatitis includes primary irritant, allergic, and photochemical dermatitis. Primary irritant dermatitis is the most common type and is caused by the direct toxicity of certain chemicals that come in contact with the skin. Allergic dermatitis involves the immune mechanism and requires prior sensitization of an individual to agents such as cosmetics, chemicals, plants, drugs, or costume jewelry (see ALLERGY). Photochemical dermatitis occurs when an individual with photosensitizing chemicals on his or her skin is exposed to light.

Atopic dermatitis, or ECZEMA, is a chronic inflammation that appears to run in families with a history of asthma and hay fever. Stasis dermatitis (eczema of the legs) is found in elderly people suffering from vascular disease.

See also: SKIN DISEASES.

dermatology [dur-muh-tahl'-uh-jee] Dermatology is the branch of medicine concerned with disorders of the SKIN, including chemical irritations, infections, allergic reactions, bites and stings, penetration by foreign organisms, and cancer. Dermatologists, the physicians who specialize in this area, also require a thorough understanding of the body and its processes; the skin is secondarily affected by many bodily disorders.


TYPES OF DERRICKS AND CRANES

derrick and crane Derricks and cranes are types of hoisting machines. The derrick, used primarily in construction, for loading and unloading ships' cargoes, and in dredging operations, is usually a stationary machine mounted on stiff legs, on a column, or attached to a wall, and often held in place by guy ropes (guy derrick). Its hoisting hook hangs from one end of a movable boom, the other end being attached by a pivot to a supporting mast. The hoisting ropes and pulleys raise, lower, and move the boom from side to side, thus lifting, lowering, and moving the load. (The term *derrick* is also applied to the rigid tower erected over wells that are drilled to reach reservoirs of oil. The derrick supports the rigging that raises and lowers the drill pipe.)

The boom on a crane—called a "jib" when it is attached in a fixed, horizontal position—is always stationary in relation to its mast. Cranes range in size from small, wall-mounted jib cranes to self-propelled or truck-mounted machines with steel latticework booms, some of enormous length. A crawler crane is mounted on a vehicle that moves on crawler, or caterpillar, tracks. The tower crane used in the construction of tall buildings is a rigid, vertical tower made of steel beams and held in position by guy ropes. A latticework steel jib at the top of the tower supports the load-lifting rigging. The load hook of the overhead traveling crane moves across the underside of the horizontal member of a stationary, bridgelike structure. The gantry crane resembles the overhead crane, except that its legs are mounted on tracks, so the entire structure moves.

Too-heavy loading of a tall crane may cause it to topple. A crane's designated capacity is the weight it can safely lift when that weight is suspended at a stated distance from the crane's center of rotation.

Derrida, Jacques [de-ree'-duh] Jacques Derrida, b. July 15, 1930, is a French philosopher and literary critic and a professor at the École Normale Supérieure in Paris. Derrida maintains that the meaning of language is elusive and hidden, and that no definitive interpretation can be established for a written text. His critical method is to "deconstruct" a text by exposing the linguistic and philosophical presuppositions concealed in it.

See also: DECONSTRUCTION.

derringer [dair'-in-jur] The derringer was a small, percussion-cap pocket pistol that enjoyed wide popularity in the United States in the late 1840s and 1850s. It was designed and manufactured by Henry Deringer, Jr., a Philadelphia gunsmith whose name, in association with his gun, eventually acquired a second *r*. The gun used to assassinate Abraham Lincoln was a derringer.

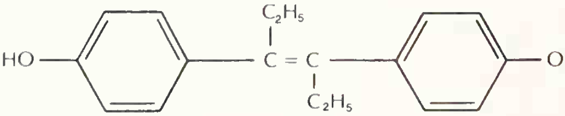
The double-barreled, two-shot derringer pistol made by Remington from 1885 to 1935 is the best-known version of the pocket pistol invented by Henry Deringer early in the 19th century. Ranging in caliber from .33 to .51, derringers were deadly at close range.

dervish In Islam, a dervish (or darwish) is a member of one of the many religious brotherhoods associated with SUFISM. Although often compared to Christian monks, most dervishes do not practice celibacy. Some Sufi fraternities advocate mystical practices that include ecstatic and hypnotic rituals of singing and dancing. Extreme forms of mysticism pervade some orders, notably the howling dervishes and the whirling dervishes.

Whirling dervishes, members of the Islamic order of mystics called Mawlawiyah, participate in frenzied dancing to induce trancelike states of ecstasy.

DES Diethylstilbestrol (DES) is a synthetic estrogen, or SEX HORMONE, used in the treatment of gynecological disorders such as menopausal disturbances, abnormal menstrual rhythm, senile vaginitis, and breast engorgement due to excess lactation. It is also used as a contraceptive. During the 1950s, massive doses of DES (50–500 mg daily) were administered to pregnant women to prevent threatened abortions and premature labor. It was later discovered that daughters of women who received this treatment run a high risk of developing vaginal cancer. Suits have been brought against DES manufacturers.

DES was one of the first nonsteroidal estrogens to be synthesized (1938) and, in one molecular configuration, is still the most potent among them. Because of structural characteristics that protect it from being inactivated by the liver, it is highly and lastingly active when administered orally. Careful and prolonged evaluation has shown that, when used properly, DES does not increase the incidence of breast and female generative tract cancers. It is used in gynecological treatment in oral doses of about 0.5 mg and is administered parenterally (outside the abdomen) to provide symptomatic relief for patients with breast and prostate cancers. It was once also frequently given to animals to accelerate weight gain before slaughtering. This practice was banned for marketable meats in the United States in 1979 because DES residues were found in the meat, but illegal use has since occurred.



Des Moines [duh moyn'] Des Moines, the capital of Iowa and seat of Polk County, is located in the south central part of the state. Lying at the confluence of the Des Moines and Raccoon rivers in the heart of the Corn Belt, it is the largest city in the state, with a population of 193,187 (1990). Des Moines is an important center of wholesaling and retailing, insurance, transportation, publishing (farm journals), and manufacturing. Its manufacturing industries include agricultural implements, recreational vehicles, machinery, apparel, metal products, dairy products, packed meat, and cement.

Drake University and Grand View College are located there. State libraries of medicine, law, genealogy, and Iowa history are nearby. The KRNT Theater, one of the largest theaters in the United States, and two community theaters add to the city's cultural attractions. Landmarks include the capitol building (1871–96), set in a 32-ha (80-acre) park; the Iowa State Fairgrounds; and the Des Moines Art Center (1958), designed by Eliel Saarinen.

Established in 1843 as Fort Des Moines, the city was assured of growth when it became the state capital in 1857. Industry was promoted by the development of local coal deposits between 1910 and 1920.

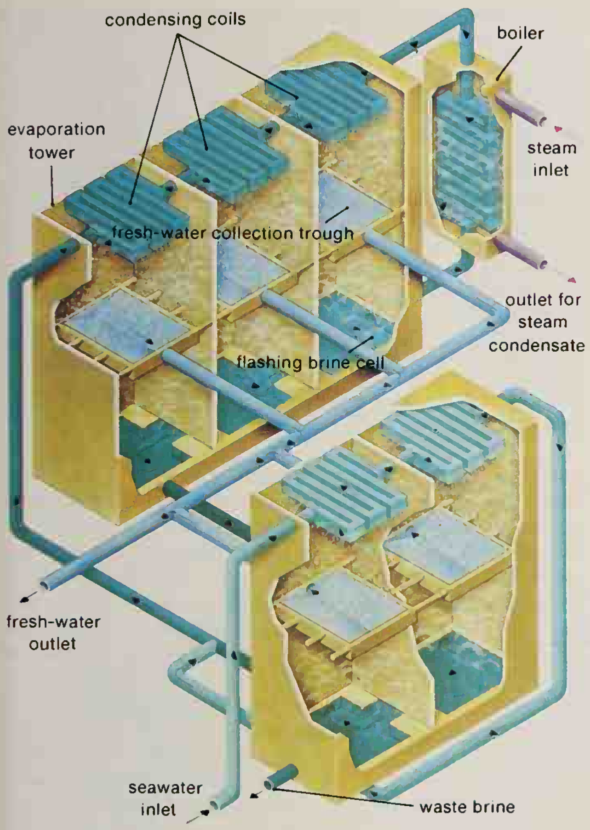
des Prez, Josquin see JOSQUIN DES PREZ

Desai, Morarji Randchhadji [dee-sy', mohr-ahr'-jee rahn-choh'-jee] Morarji Randchhadji Desai, b. Feb. 29, 1896, served as prime minister of India from 1977 to 1979. After India won its independence he held various cabinet posts. In 1969 he broke with Prime Minister Indira GANDHI and became a leader of the opposition to her government. He led his Janata party to victory in the elections of March 1977 and became prime minister on March 24. His government restored the democratic institutions suspended by Mrs. Gandhi since 1975.

desalination Desalination refers to the processes employed to render brackish or ocean water fit for human consumption, irrigation, or industrial use by removing the salt it contains. The need for economical desalination processes has grown in recent decades, as supplies of fresh water prove insufficient for growing populations and as semiarid areas are urbanized or brought under cultivation. Several types of desalination processes are currently used. The choice of process is determined by the condition of the unpurified water, the energy source available to power the desalination plant, the production rate of fresh water required, and the capital cost. The price per unit of processed water varies widely; it is affected mainly by the type and amount of energy used.

Distillation

In principle, DISTILLATION is a simple process. Salt water is boiled, and the steam evolved is collected and condensed into desalinated water; the salts remain in the unvaporized brine. In an efficient distillation process, some of the steam heat is transferred back into the salt water to improve the thermal efficiency. The most widely used distillation process, multistage flash distillation (MSF), is based on the principle that water will boil at lower temperatures when it is subjected to lower pressures. In the MSF process, heated seawater is led into a flash chamber



In multistage flash evaporation, cool seawater is heated by passing it through a series of condensing coils and a boiler. The hot brine then passes into an evacuated evaporation tower, where it immediately boils because of the partial vacuum. The vapor that flashes off is cooled and condensed by the coils containing the incoming brine. The freshwater condensate is collected in a trough and eventually stored. The same process occurs in successive towers, each of which is held at a greater vacuum than the preceding one, to compensate for the increased boiling point of the brine as it loses water in each tower. In the last tower, part of the final concentrated brine is blended with the incoming seawater and part is discarded.

in which the pressure is just low enough to cause some of the water to boil and flash off hot vapor. The vapor is condensed on the tubes that carry fresh, cool seawater into the system. A large MSF plant may have 60 flash chambers.

Multiple effect boiling (MEB) also uses a series of containers, known as effects. Part of the total pure-water output is produced by flashing, as in the MSF process, but the largest portion is produced by boiling, using the steam generated in one effect as the heat source for the next effect.

These distillation systems require an outside source of heat-producing energy. Also, in all distillation processes the problem of scale formation—the deposit of some of the salts, particularly calcium sulfate, on the heat-transfer surfaces—is encountered. Scale formation, which increases as the water temperature increases, lowers the efficiency of the heat-transfer process.

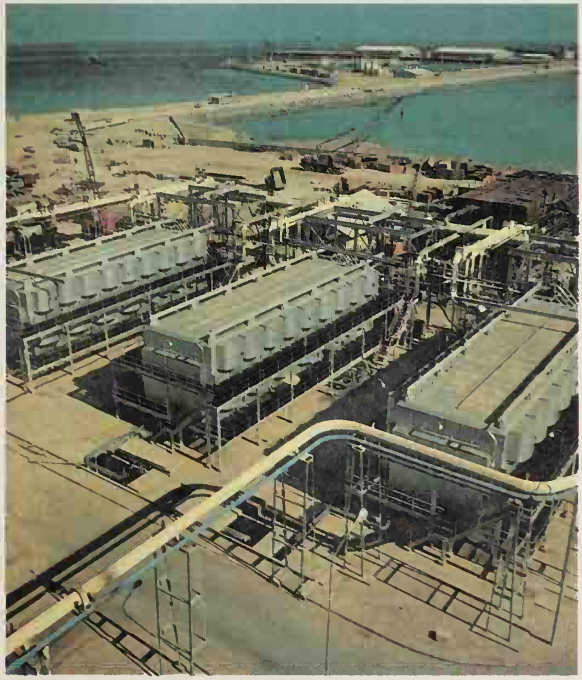
Solar distillation operates on the principle that water evaporates from the surface of a body of water at a temperature below the boiling point. Seawater is led into large black basins, called solar stills, which are covered with glass or plastic. Solar heat is absorbed by the saline water and the basin; vapor from the heated water condenses on the cooler glass cover and is drawn off as pure water. To operate effectively, solar stills must be located in areas where the Sun's heat is intense and constant, and they must be large: 2,000 cm^2 (2 ft^2) of water surface produces only about 1 liter (0.26 U.S. gal) of fresh water a day.

Another solar technology, OCEAN THERMAL ENERGY CONVERSION (OTEC), can be adapted to vaporize brine, using flash distillation processes powered by the OTEC plant itself.

Membrane Processes

The use of porous membranes to produce desalinated water is a technique that works best on brackish waters, which have a low salt content. One such process, called electrodialysis, uses the principle that dissolved salts become negatively and positively charged ions (anions and cations). In an electrodialysis cell, saline water is passed between two different membranes, each of which passes one type of ion. When an electric field is applied, the an-

The world's largest group of desalination plants is found in Kuwait on the southern shore of the Persian Gulf. This group of plants produces 23 million liters (6 million gallons) of fresh water per day.



ions and cations pass through their respective membranes, producing desalinated water. (See DIALYSIS.)

Reverse OSMOSIS is another important membrane process. When a membrane permeable only to pure water is placed between pure and saline water, a driving force, or pressure—which is created by the concentration of salt in the saline water—causes the pure water to pass through the membrane. If a pressure greater than this osmotic pressure is applied to the saline water, the process is reversed: pure water passes out of the saline water. With new, improved membranes, reverse osmosis is becoming a practicable and comparatively inexpensive process for desalinating seawater.

To date, the main market for desalination plants has been the Middle East, where an artificial water supply is needed and cheap fuel to power the plants is available.

René Descartes, the French philosopher and mathematician, is considered the founder of analytical geometry. Motivated to find a starting point for a philosophy based on certitude, he developed the method of systematic doubt, through which he arrived at his famous Cogito, ergo sum *(I think, therefore I am).*

Descartes, René [day-kart', ren-ay'] The French philosopher René Descartes, b. Mar. 31, 1596, d. Feb. 11, 1650, made major contributions to both philosophy and mathematics. His principal philosophical work, *Meditations on First Philosophy*, was first published in 1641, the year before Galileo died and Isaac Newton was born. One of his two main aims in philosophy was to provide a conceptual foundation for the new mechanical physics, which tried to explain everything in the created world external to human beings solely by the shapes, sizes, and motions of bodies. Because Descartes lived at a time when traditional ideas were being questioned, he also sought to devise a method of inquiry for reaching the truth. This concern and his method of systematic doubt had an enormous impact on the subsequent development of philosophy.

Life and Works. Born in Touraine, France, Descartes was educated at the Jesuit academy of La Flèche. He traveled through Europe as a volunteer in a Dutch and then a Bavarian army. In his early twenties he began working on problems in mathematics and mechanics under the influence of the Dutch scientist Isaac Beeckman, and he first conceived of developing a unified science of nature.

Upon hearing of Galileo's condemnation by the Inquisition in 1633 for defending the Copernican system, Descartes suppressed publication of his own work *The World*, in which he had taken the same position. His three most important philosophical works, the *Discourse on Method*—which was a preface to his *Dioptrics, Meteors and Geometry*—the *Meditations on First Philosophy*, and the *Principles of Philosophy*, were published in the period from 1637 to 1644. Also important are *The Passions of the Soul, Notes Against a Program*, and his correspondence.

In 1649, Descartes was persuaded by Queen Christina of Sweden to leave Holland for Stockholm, where, after only a few months, he caught pneumonia and died.

Cartesian Philosophy. Descartes adopted the strategy of withholding his belief from anything that was not entirely certain and indubitable. To test which of his previous beliefs could meet these conditions, he subjected them to a series of skeptical hypotheses. For example, he asked himself whether he could be certain he was not dreaming. His most powerful skeptical hypothesis, that there is an evil demon trying to deceive him, challenges not only the belief that the physical world exists, but also belief in simple statements of arithmetic, such as 2 + 3 = 5, and thus would seem to call into question the validity of reason itself. But not even an evil demon could deceive someone into believing falsely that he existed. "I think, therefore I am" is thus beyond skeptical doubt. From this premise, Descartes attempted to infer the world called into doubt by his skeptical hypotheses. He thus invoked skepticism only as a means of reaching certainty. However, his arguments to overcome skepticism are not without their problems. One of these is known as the Cartesian circle: no argument to show that God exists can be certain unless one is certain of one's own reasoning; but, according to Descartes, one cannot be certain of one's reasoning unless one is certain that God exists.

Descartes is known as the father of the mind-body problem. He claimed that human beings are composites of two kinds of substances, mind and body. A mind is a conscious or thinking being, that is, it understands, wills, senses, and imagines. A body is a being extended in length, width, and breadth. Minds are indivisible, whereas bodies are infinitely divisible. The "I" of the "I think, therefore I am" is the mind and can exist without being extended, so that it can in principle survive the death of the body. Despite having different natures, Descartes thought that mind and body causally interact. The human mind causes motions in the body by moving a small part of the brain. Motions in that same part of the brain produce sensations and emotions.

Descartes argued that colors, sounds, tastes, smells, heat, and cold are merely sensations existing in thought, and there is nothing in bodies that resembles them, just as there is nothing in bodies that resembles the sensation of pain. The only properties of bodies are those which are capable of being quantified, namely, extension and its modes, shape, size, and motion. He denied the existence of a vacuum, because what one would be inclined to call empty space meets his definition of body in virtue of being extended in three dimensions. All the phenomena in the created world external to humans, such as gravity, magnetism, and the cohesion of bodies, as well as the complex functioning of living organisms including human bodies, he believed could be explained solely by mechanistic physics, that is, by the motions and collisions of bodies. He even denied that consciousness must be attributed to animals in order to explain their behavior.

In mathematics Descartes is famous for the unification of algebra and geometry, marked by the use of what are now known as Cartesian coordinates. He influenced not only the rationalist and empiricist thinkers who were his immediate followers (see RATIONALISM; EMPIRICISM), but also the whole course of modern philosophical enquiry, and the Cartesian quest for certainty gave EPISTEMOLOGY the central place in philosophical thought it maintained until the 19th century.

descent group see KINSHIP

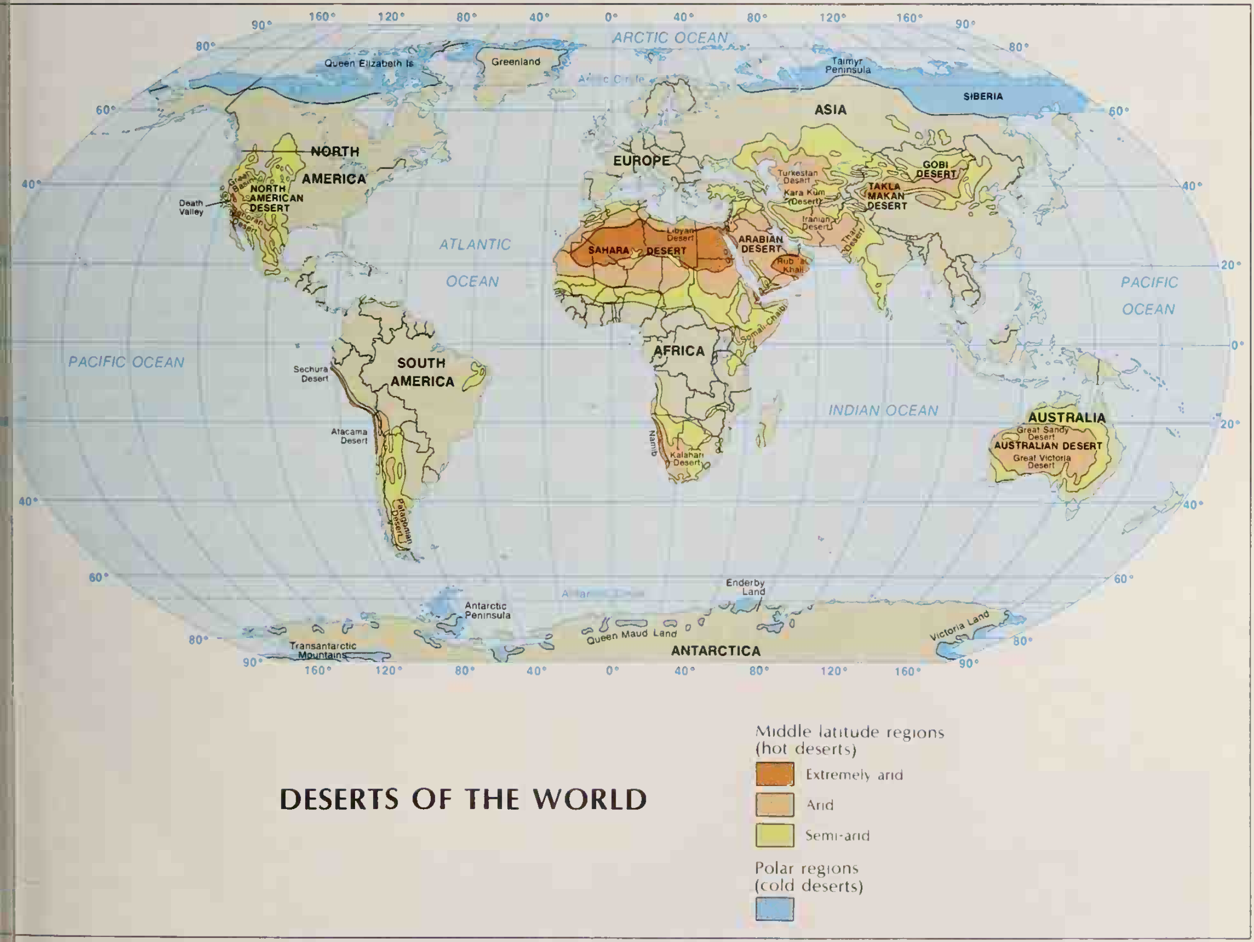
descriptive geometry see PROJECTIVE GEOMETRY

desegregation see INTEGRATION, RACIAL

desensitization see ALLERGY

desert Deserts are arid land areas where more water is lost through evaporation than is gained from precipitation. Several types of deserts are recognized in addition to the familiar hot, dry desert of rock and sand that is almost barren of plants. They include semiarid deserts of scattered trees, scrub, and grasses; coastal deserts, such as the Atacama of Chile; and the deserts on the polar ice cap of the Antarctic and Greenland.

Geographers generally categorize deserts as one of two basic types that, together, contain an almost unlimited variety of landscapes, BIOMES, CLIMATES, and cultural and natural resources. Deserts of the first major group, the result of large-scale climatic patterns, develop in regions of



DESERTS OF THE WORLD

persistent high atmospheric pressure, where descending AIR MASSES are compressed and heated. Those of the second major type may occur behind any large mountain range that forms a rain shadow, blocking the inland flow of moist ocean air.

Desert Areas of the World

The deserts of the world are discontinuously distributed in a pair of parallel belts lying about 25° north and south of the equator. Of these, the Northern Hemisphere Sahara (the world's largest desert) and the many smaller deserts forming much of the arid portion of the Middle East are HIGH-PRESSURE REGIONS directly related to global circulation of the atmosphere. In the Southern Hemisphere, western coastal deserts of South America (the ATACAMA), southern Africa (the NAMIB and the KALAHARI), and the entire continental interior of Western Australia are arid because they lie under the eastern side of persistent high-pressure areas.

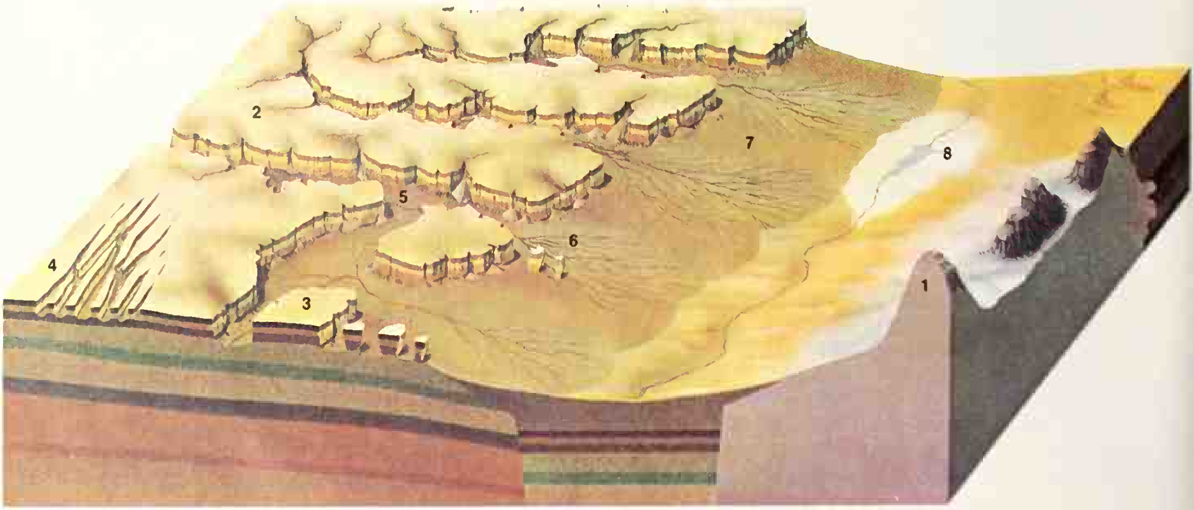
Other Northern Hemisphere deserts are rain-shadow deserts, such as the MOJAVE of Nevada and eastern California, which lies inland beyond the wall of the Sierra Nevada. In central China, the high, cold GOBI Desert lies north of the Himalayas, the world's highest mountains, which block moist air masses sweeping north from the Indian Ocean. The deserts of eastern and central Australia are a product of the Great Dividing Range and other mountains on the east side of the continent that lie across the path of the prevailing southeasterly TRADE WINDS, thus creating rain-shadow deserts inland.

Because the climatic characteristics of individual deserts may vary from season to season, techniques have been developed to measure a land area's general aridity, where precipitation is exceeded by potential loss of water by evaporation and plant transpiration. In the driest desert areas, mean annual precipitation commonly ranges from a maximum of 430 mm (17 in) to 0 mm, with periods of as much as 30 months when no rain is recorded. In general, throughout desert areas mean annual temperature ranges from 2° to 18° C (35° to 65° F) for cold deserts and from 18° to 27° C (65° to 80° F) for hot deserts. Another useful index of desert conditions correlates evaporation and precipitation. In the vicinity of Las Vegas, Nev., for example, a mean annual precipitation of 90 mm (3.5 in) is counterbalanced by a mean annual evaporation of 1,830 mm (72 in). Measured by these indexes of aridity, more than one third of the Earth's total land surface exhibits desert characteristics. Of the Earth's total land surface area, 4% (5.4 million km^2/ 2.2 million mi^2) is extremely arid, 15% (20.3 million km^2/7.8 mi^2) is arid, and 14.6% (19.7 million km^2/7.9 million mi^2) is semiarid.

Water Sources

With such a large percentage of the Earth's land surface marked by a moisture imbalance, the presence of water is of major importance. Desert water sources are of two major types: surface, including all streams, rivers, and lakes; and subsurface, including all springs and wells. Surface water is commonly temporary, consisting of short-lived streams produced by local, violent THUNDERSTORMS. In areas where closed basins have no outlet to the sea, shallow temporary lakes may form. Normally, such streams and lakes are not dependable water supplies.

Deserts lack the sloping land formations produced by regular rainfall. Instead, they are characterized by angular, wind-buffeted rock outcroppings (1). *Flat, steep-sided mesas* (2), *isolated buttes* (3), *and elongated trough formations resulting from wind abrasion* (4) *are typical of desert topography. The minimal desert rainfall, less than 10 cm (4 in) annually, generally comes as flash floods that rapidly erode rocky surfaces and form steep valleys known as arroyos or wadis* (5). *Sediments carried by the rushing streams are deposited at the mouths of these canyons, where water decreases in velocity as it spreads from its narrow course. The resultant alluvial fans* (6) *may occur in a sequence, constituting a bajada slope* (7). *Fine mud and dissolved salts may be carried into large flat areas to form shallow lakes or salt pans* (8) *that evaporate within a few days.*



Sand dunes formed perpendicular to the wind direction are known as barchans. These crescent-shaped dunes, found in Venezuela's desert region, creep forward as sand is blown up the windward slope and rolls down the steep leeward side.

Desert rock formations, such as these beside the Dead Sea, were sculpted by centuries of abrasion, as the prevailing winds bombard exposed rock surfaces with sand grains. This weathering gradually reduces desert rocks to irregular outcroppings.

A form of surface water that is critical to human life in desert areas is the permanent river that originates in humid areas outside deserts and then flows across desert land en route to the sea, as do the Nile in Egypt and the Tigris-Euphrates in Iraq. With irrigation water supplied by these river systems, the two areas became cradles of civilization. In the New World, systematic development of the Colorado River, a permanent river in the southwestern United States, has led to increasingly extensive agricultural programs in Arizona and California.

Subsurface water supplies derive from springs and wells. Springs occur where the land surface intersects the WATER TABLE; they may give rise to small, well-watered areas (oases) that serve as a limited agricultural base for small, local populations. Porous sedimentary rocks may be pierced by drilling to bring water to the surface, thus increasing the water supply from GROUNDWATER sources. Greater agricultural and urban development of desert areas requires extensive networks of wells. These may tap groundwater at depths of more than 300 m (1,000 ft). Since, in most desert areas, supplies of groundwater are limited and have taken thousands of years to accumulate, withdrawal of groundwater usually leads to depletion of the local supply and may sharply limit the extent and duration of desert development. Heavy groundwater withdrawals can also cause widespread subsidence of the land surface, with adverse effects on construction such as roads and canals.

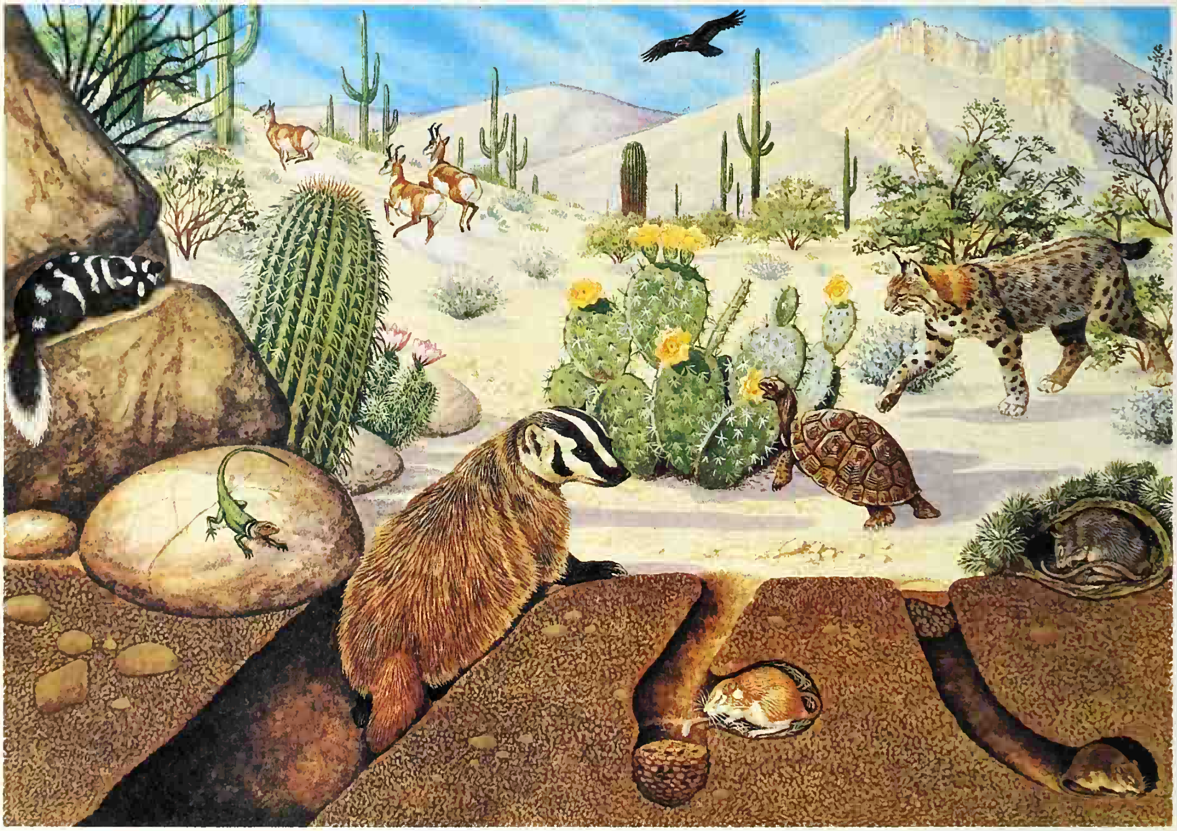
The Desert Landscape

A barren landscape of rock, soil, and sand resulting from thousands of years of aridity is perhaps the most familiar aspect of deserts. This environment is created by the geologic processes of EROSION AND SEDIMENTATION that are responsible for all of the Earth's landforms (see LANDFORM EVOLUTION).

In deserts, the fluvial (running-water) processes of erosion and deposition operate differently than in humid climates, mainly because desert rainfall is so erratic. Arid landscapes may remain dormant for long periods, when neither erosion nor deposition occurs. Then, a single heavy thunderstorm will produce rapid changes that persist until the next such event.

Among the common fluvial erosional forms are dry stream channels (called arroyos in American deserts or wadis in the deserts of Africa and the Middle East). Desert landforms produced by deposition occur along the margins of mountain fronts. Consisting of great thicknesses of coarse debris weathered from the rock slopes and transported for relatively short distances, these deposits tend to be conical in shape, originating at the mouths of short, steep canyons and spreading in a fan-shaped pattern (see ALLUVIAL FANS). Where mountain ranges enclose basins that have no outlet (as in the North American BASIN AND RANGE PROVINCE), intermittent lakes with hard crusts of clay or salt form during dry periods. In deserts of the Western Hemisphere, these lakes are called PLAYAS or salars (see EVAPORITE).

Wind is responsible for the other major processes that shape desert landscapes. In some regions prevailing winds that occur frequently and with sufficient velocity to move sand may be the dominant force shaping the landscape. This wind action results from a combination of conditions: sparse vegetation; dry, unconsolidated soils; broad areas with little topographic relief; and favorable location with respect to the global pattern of high and low



atmospheric pressure. Wind-caused (eolian) landforms fall naturally into two categories: erosional (deflation) structures; and depositional features, most commonly SAND DUNES. South of the Sahara desert, where southerly winds move sand great distances, the process of desertification is evident. Characterized by the encroachment of deserts into nearby regions, desertification results in the loss of fertile land and leads to soil erosion and overcultivation.

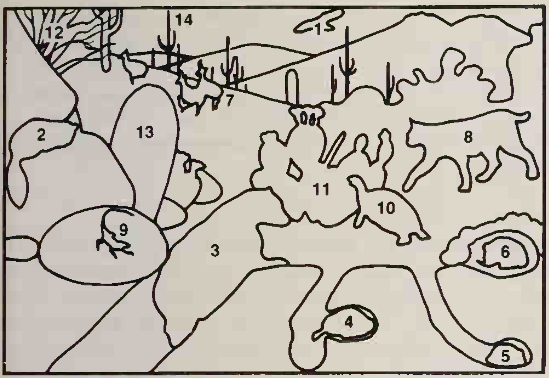
Desertification has been an active force in the Middle East and Africa for the past several thousand years, with deserts constantly encroaching on inhabited semiarid regions because of overgrazing and deforestation. As a result, the southern boundary of the Sahara has advanced 1,000 km (600 mi) southward, with devastating impact on the people of a vast region—the SAHEL—south of the Sahara (see DROUGHT).

desert life All desert plants and animals have had to adapt to water scarcity and temperature extremes. Many have succeeded in making the desert their home, and many can live nowhere else.

Plants. Desert vegetation is typically low and widely spaced. In general, plants survive by either escaping or enduring the arid conditions. Annuals escape DROUGHT because their seeds can lie dormant for many years; germination proceeds only when the right amount of rain at the right temperature removes inhibitors from the seed. During the rare years when this occurs, these plants may rapidly grow to form extensive desert gardens. Perennials that shed their tops after the growing season evade the drying heat as underground bulbs and tubers.

Succulents, such as the American CACTI and AGAVES and the African euphorbias (see SPURGE), are successful because of their ability to store water. Shallow, widespread roots, often with special rootlets, quickly absorb rainwater. Cacti are typically leafless and spiny and have a thick, waxy cuticle and sunken stomata that close by day to conserve water.

Unlike water-storing succulents, most perennials must endure arid conditions. To reduce water loss by transpiration, some may have tiny leaves, as in SAGEBRUSH, *Artemisia*; or waxy leaves, as in the CREOSOTE BUSH, *Larrea tridentata*. Others may shed their leaves, as in ocotillo, *Fouquieria splendens*; or shed entire branches, as in brittlebush, *Encelia farinosa*. Spines, hairs, thick leaves, and the ability to change leaf position are also common adaptations. The extensive root systems of plants such as the phreatophytes spread out over wide areas or reach far down to tap the available water. MESQUITE, *Pro sopis*, has



Wildlife of the Sonoran Desert, in the southwestern United States, exhibits great adaptability to climatic extremes. Because daytime temperatures in the desert approach 54° C (129°F), animals and plants need means of surviving excessive heat and aridity. The turkey vulture (1) *can venture into the desert because of its capacity for extended flight in cooler air layers. Many desert mammals, such as the spotted skunk* (2) *and the badger* (3), *are nocturnal, seeking shelter during the day in underground burrows. Some rodent species—for example, the kangaroo rat* (4), *the pocket mouse* (5), *and the pack rat* (6)*—almost never drink; instead, their bodies obtain fluids from the breakdown of plant matter and insects on which they feed. In the background, pronghorn antelopes* (7) *flee at the approach of a bobcat* (8); *they are likely to meet again, because both frequent the same watering holes. The green collared lizard* (9), *like all reptiles, assumes the temperature of its environment and must regulate body temperature by maneuvering in and out of direct sunlight. The desert tortoise* (10) *finds all the liquid necessary to sustain life from the spiny, but water-laden, prickly pear cactus* (11). *Cacti, such as the ocotillo* (12), *the barrel cactus* (13), *and the saguaro* (14), *are equipped with spines rather than leaves to minimize moisture loss from evaporation.*

roots that extend 9 to 30 m (about 30 to 100 ft) to reach underground water. Some desert plants, such as pygmy cedar, *Peucephyllum schottii*, may remain green even during dry periods by absorbing dew. Others become inactive during extended dry periods; some, such as the creosote bush, can tolerate considerable dehydration. Trees that grow only in washes, such as PALO VERDE, *Cercidium*, have a hard seed that must be cracked in order to germinate. The rushing, debris-laden waters of a storm can accomplish this, while also supplying water for growth. The wide spacing of plants, such as that demonstrated by the dominant creosote bush of the Sonoran Desert, is believed to be partly a result of seedling-inhibiting substances produced by the mature plants and partly of the limited supply of water.

Animals. Many animals thrive in the desert, including insects, arachnids, reptiles, birds, and mammals. Animal and plant life are delicately interrelated. Plants are used as food, shelter, and protection by the animals, which in turn help pollinate plants and disperse seed. Like plants, animals meet harsh desert conditions by escaping or enduring them.

Animals, unlike stationary plants, can readily retreat from unfavorable conditions. Most small animals escape the heat of day in cool underground burrows. Governed by biological clocks, burrowing animals come out to hunt for food either at night or in early morning and at dusk, when temperatures are lower. Those animals too large for burrowing seek shade, and reptiles, whose body temperature is controlled by the temperature of their environment, travel between sunlight and shade to stay cool. Birds, which show few adaptations except for the paler color of most desert animals, can soar to cool upper levels, and they may migrate during the harsher seasons. Seasonally, animals often cope with arid conditions by aestivating (see HIBERNATION). Similarly, the eggs of egg-bearing animals, like the seeds of desert plants, may remain dormant. This enables such unlikely animals as amphibians and freshwater shrimp to live in temporary desert pools.

Some small mammals, such as rodents, conserve water by excreting only concentrated urine and dry feces and by reducing perspiration. Lethal temperatures bring about copious salivation as an emergency cooling measure. The KANGAROO RAT can live without drinking, getting enough water from the metabolic breakdown of the dry seeds it eats. Others get water from eating animals or succulent plants. Insects have protective waxy coatings and long legs to keep them above the hot ground; their excretions are, like those of rodents, almost moistureless. To aid travel on loose sand, lizards have snowshoelike fringed toes. Snakes, such as the SIDEWINDER, have a distinctive form of locomotion. Burrowers are protected by special nostril and ear valves. The well-adapted CAMEL tolerates a body temperature of 40.5° C (105° F) before sweating. It can lose 30 percent of its body weight and replace it at a single rapid drinking. Animals of different deserts of the world show remarkable similarities as a result of adapting to similar conditions; examples are the American kit fox, *Vulpes macrotig*, and the Sahara fennec fox, *Fennecus zerda*.

desertion Desertion, in civil law, is the act of leaving a marital partner without adequate justification. In most states of the United States it is grounds for divorce, and in all of them it is grounds for legal separation. Desertion is more than absence. It must be a willful abandonment of the other party, without justification and without consent, with no intention of returning, and it must persist for a substantial period of time. The law of desertion is complex because in divorce cases a spouse who can be held guilty of desertion may be denied rights to ALIMONY and inherited property. Thus, a spouse who runs away and decides to return may legally maintain that the desertion has ended, and the other spouse may be required under certain circumstances to take back the returning partner on pain of becoming, in turn, the deserter.

Desertion, under military law, is leaving the armed forces without permission, with no intention of returning to duty. It differs from the less serious act of simply being absent without leave (AWOL). Long absence is usually regarded as proving intent to remain away. During wartime, however, in some countries, even a brief absence may be considered desertion, and be punishable by death.

The Laughing Boy *(c.1462) is one of three life-size portraits of young children attributed to Desiderio da Settignano. The work reveals the artist's sensitivity to the moods of childhood. (Kunsthistorisches Museum, Vienna.)*

Desiderio da Settignano [day-zee-dair'-yoh dah set-teen-yah'-noh] Desiderio da Settignano, b. *c.*1430, d. January 1464, was a Florentine sculptor whose brief career coincided with the growing market in Italy for privately commissioned works and whose technical skill in his chosen medium, marble, agreed with the Renaissance taste for elegance and refinement. Although, as was the custom, he signed none of his works, there is documentation for two major commissions in marble. These are the *Sacrament of the Tabernacle*, San Lorenzo, Florence (partially installed 1461), and the *Tomb of the Chancellor Carlo Marsuppini*, Santa Croce, Florence (begun 1453).

There are no records of Desiderio's early training, but he was probably affiliated with DONATELLO during his formative years; more than any other sculptor of his time, Desiderio absorbed and reinterpreted Donatello's style in the treatment of the subtle interplay between mother and child and in the technique of *relievo schiacciato* (flattened relief) in marble.

Although Desiderio is remembered for his portraits of women and small children, he also depicted profound emotion and subtle nuances of expression. A number of works formerly attributed to Donatello are now ascribed to the younger master, including the *Martelli Saint John* (*c.*1458) in the Museo Nazionale, Florence.

desman [dez'-muhn] The desman is a semiaquatic, molelike mammal. The Russian desman, *Desmana moschata*, native to south central Eurasia, is the largest member of the mole family. It grows to 21.5 cm (8 in) long, with a 21.5-cm (8-in) tail. It inhabits the banks of quiet ponds and streams and feeds on insects, crayfish, and other small animals. The Spanish desman, *Galemys pyrenaicus*, found in the Pyrenees and in Portugal, is smaller but of similar habits. Desmans are trapped for their fur.

The Russian desman, native to the river regions of the western USSR, sometimes swims snorkellike, with only the tip of its long snout above the water. The desman is an endangered species because it is hunted for its otterlike fur.

desmid [dez'-mid] Desmids are tiny green algae found floating about in bodies of fresh water throughout the world. Desmids belong to the order Zygnemarales, division Chlorophyta (green algae). Like diatoms (golden-brown algae), desmids are a major constituent of plankton and are thus an important source of food for fish and other aquatic animals. Unlike diatoms, desmids do not have an outer shell and are never found in salt water.

Desmids are one-celled organisms that live singly or as colonies. The colonies either are threadlike or have no definite shape. Most desmid cells are constricted, or pinched in, at the middle, forming two identical semicells joined together by a connecting isthmus. A single nucleus is located in the isthmus. Each semicell typically contains one chloroplast, the tiny structure containing the green pigment chlorophyll.

Desmids reproduce both sexually and asexually. In asexual reproduction the two semicells simply split apart. In sexual reproduction they undergo a process known as conjugation, in which the cellular contents (protoplasts) of two cells emerge and unite to form a zygote. The zygote later germinates and eventually gives rise to new cells.

despotism Despotism is a form of government in which the ruler has unlimited, or absolute, powers to make decisions that affect the lives of his or her subjects (see ABSOLUTISM). Since the early concept of despotism implied the consent of the ruled, it was differentiated from tyranny. Despotism should also be distinguished from DICTATORSHIP, in which absolute powers are supposedly assumed to deal with a temporary emergency. Although despotism may be oppressive, many despots have attempted to improve the quality of life within their realms. Such 18th-century European rulers as CATHERINE II of Russia and Holy Roman Emperor JOSEPH II were known as "enlightened despots." Today the term *despot* describes rulers who accept no constitutional restraints on their power.

Dessalines, Jean Jacques [day-sah-leen'] Jean Jacques Dessalines b. *c.*1758, d. Oct. 17, 1806, was the first ruler of independent Haiti (1804–06). He was an illiterate plantation slave when he joined the earliest struggles against both French rule and the mulatto elite. He served as lieutenant to TOUSSAINT L'OUVERTURE until the latter's capture in 1802. Dessalines then inherited the black leadership of the colony and forged an alliance of convenience with the mulatto leader Alexandre PÉTION.

In 1804, after the French had been driven out, Dessalines proclaimed Haiti independent, making it the first free nation in Latin America, and had himself appointed president. Later in the same year he proclaimed himself Emperor Jacques I, in imitation of Napoleon I. Dessalines ruled dictatorially. He nationalized all property held by Europeans and most mulatto-owned lands and forced the black lower class either to enter the military or to work as field hands. He was assassinated near Port-au-Prince during a revolt led by Pétion.

Dessau [des'-ow] Dessau (1987 est. pop., 103,500) is an industrial city in east central Germany, situated about 115 km (70 mi) southwest of Berlin. It is the commercial center for the surrounding agricultural and coal mining region, and local industries produce heavy machinery, chemicals, glass, paper, textiles, and sugar. Located on the Mulde River near its confluence with the Elbe, it is also an inland port.

Dessau was settled during the early Middle Ages by Wends, a Slavic group, and it became a German village during the 12th century. From 1603 until 1918 it was the capital of the principality of Anhalt-Dessau. During World War II, 80% of the city was destroyed by Allied bombing.

destroyer The term *destroyer*, like the class of warship it describes, originated in the torpedo-boat destroyer of the 1890s. By World War I these ships had grown from some 300 tons displacement to about 1,000, and by World War II some exceeded 3,000 tons. Typical armament consisted of several multiple-torpedo-tube mounts and from three to six guns in the 5-inch category, on single or twin mounts protected by unarmored blast shields. Sensors included hydrophones, active SONAR devices for locating submarines, and eventually, RADAR. During World War II destroyers also assumed an important role in providing antiaircraft protection for major fleet units.

The destroyer's antisubmarine function grew steadily in importance after World War II. Since the 1950s it has been designed primarily as a missile-launching platform. Today the distinction between a large destroyer and a small CRUISER, or between a small destroyer and a large FRIGATE, is increasingly arbitrary.

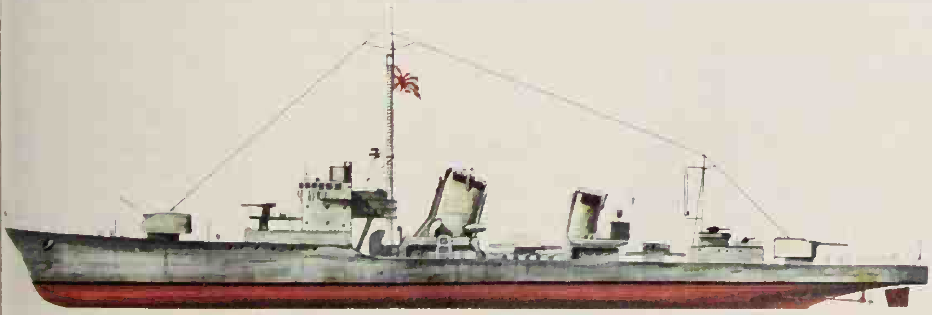
See also: NAVAL VESSELS.

detective story see MYSTERY, SUSPENSE, AND DETECTIVE FICTION

detector, particle Particle detectors are instruments designed for indirectly observing atomic and subatomic particles. Such particles, discovered only in this century, occur in a bound state in atoms and in a free state in radioactivity, cosmic rays, and the aftermath of nuclear reactions.

General Principles. All methods of particle detection are indirect and involve the interaction of particles with other matter. Direct observation with light rays is precluded by the relatively long wavelength of visible light compared with the size of the particles, and the information obtainable with shorter-wavelength (and thus more energetic) radiation is limited by the UNCERTAINTY PRINCIPLE. The particle data include charge, mass, and especially number and kinetic energy. All particle detectors are suitable for counting the number of particles that pass through a given volume of measuring medium per unit of time. In general, a particle passing through that volume raises the atoms in it to a higher, or excited, energy state. In most cases the transfer of energy is great enough to ionize the medium, but this usually occurs only if the particle under investigation is charged. An uncharged particle can only be detected when it undergoes a nuclear reaction with an atomic nucleus in which charged particles are set free.

Types. There are three types of particle detectors. Ionization detectors, such as the GEIGER COUNTER, the SPARK CHAMBER, and the proportional counter, are based on the ionization of gases in the measuring medium. Two electrodes are present in the medium, and a high voltage is applied to them. When a particle gives rise to ionization, the high voltage attracts the ions formed, so that a current pulse between the electrodes can be measured. In the spark chamber the ionization is accompanied by the passage of a spark between the electrodes. Under suitable conditions in the proportional counter, and only at low voltages in the Geiger counter, the current pulses are approximately proportional to the energy of the particles.



The Yukikaze, *a 2,000-ton Japanese destroyer constructed in 1940, participated in most of the major naval engagements fought in the Pacific theater during World War II. It was one of 18 destroyers built to similar specifications (the* Kagero *class).*

The Crystal Ball is a device used to detect high-energy photons in particle-accelerator experiments involving meson decays. The Crystal Ball was moved from Stanford Linear Accelerator Center in California to Desy Laboratory in West Germany in 1982.

SCINTILLATION COUNTERS, the second type, count the light flashes that occur when excited atoms drop back spontaneously into their normal state. A flash is recorded by using the current first stimulated, which is then multiplied in a special electronic tube known as a PHOTOMULTIPLIER tube. Track detectors, the third type, contain a space in which a substance is present in a metastable, or barely stable, phase and subsequently passes locally into the stable phase under the influence of the ionizations. In this group, the CLOUD CHAMBER operates on the principle that liquid droplets will condense in a supersaturated vapor, and the BUBBLE CHAMBER involves a liquid-to-gas phase change with the accompanying formation of bubbles. The resulting tracks are usually photographed so that their curvature and length can be measured precisely, yielding information about the particles. Multiwire chambers—gas-filled chambers containing a plane of parallel, very fine wires with a positive electric potential—also provide such information.

Developments. Detectors of the bubble-chamber type are used in association with the particle ACCELERATORS employed in high-energy physics. The storage rings and colliding beams now common at such facilities require increasingly sophisticated detecting devices. One such device, built at the Stanford Linear Accelerator Center in California, is called the Time Projection Chamber (TPC). The TPC is a cylinder, 6 m (19.7 ft) long and filled with argon and methane, in which a uniform electric field has been generated. It can measure, simultaneously and in three dimensions, the large numbers of ionization tracks emanating from a particle collision that takes place in the center of the cylinder. Three-dimensional tracking is also provided by the Collider Detector Fermilab (CDF) at the Fermi National Accelerator Laboratory. Weighing more than 4,000 metric tons (about 4,500 U.S. tons), it surrounds the site of proton-antiproton collisions and has a layered structure with a gas-filled chamber for tracking particles, lead plates for detecting photons and electrons, and steel plates for heavier particles.

detergent see SOAP AND DETERGENT

determinant A determinant, in ALGEBRA, is the sum of certain products of numbers that are expressed as elements in a square array, or MATRIX. Certain rules govern the multiplication and summing of the matrix elements, which are given subscripts according to their row and column positions. The determinant is now used mainly in certain theoretical arguments.

determinism Determinism is the theory that all human action is caused entirely by preceding events, and not by the exercise of a cause-free WILL. The theory is based on the principle that an uncaused event is impossible or incomprehensible. The success of scientists in discovering causes of certain behavior and in some cases effecting its control tends to support this principle.

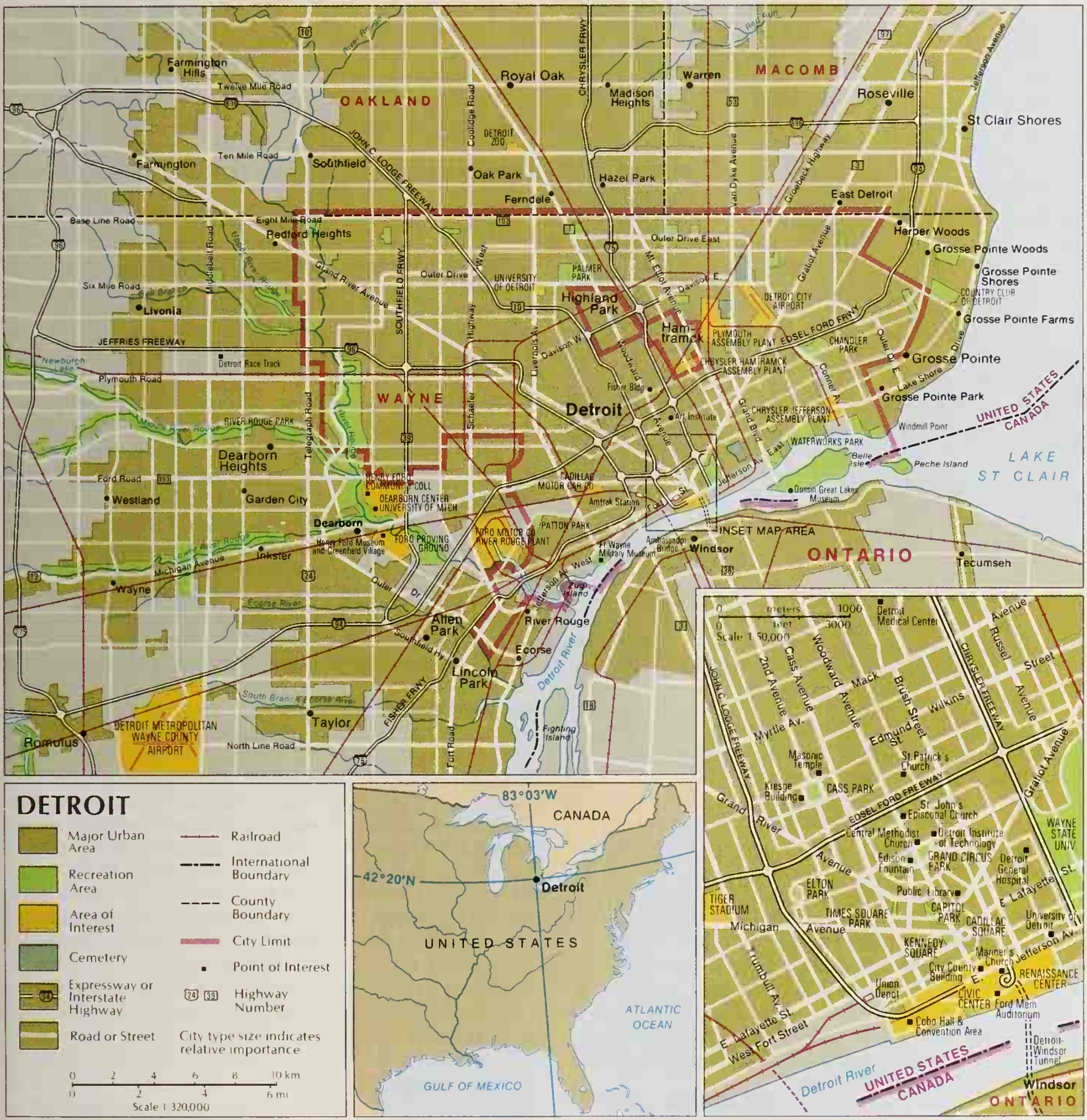
Disagreement exists about the proper formulation of determinism. Physical determinism, which has its origin in the ATOMISM of DEMOCRITUS and LUCRETIUS, is the theory that human interaction can be reduced to relationships between biological, chemical, or physical entities; this formulation is fundamental to modern SOCIOBIOLOGY and neuropsychology. The historical determinism of Karl MARX, on the other hand, is transpersonal and primarily economic. In contrast to these two formulations, psychological determinism—the philosophical basis of psychoanalysis—is the theory that the purposes, needs, and desires of individuals are central to an explanation of human behavior. The behavioral determinism of B. F. SKINNER traces the causes of human behavior to the positive or negative effects of earlier behaviors. His account also uses modern statistical and probabilistic analyses of causation.

Some contemporary philosophers, including Jean Paul SARTRE, have argued that determinism is controverted by INTROSPECTION, which reveals actions to be the result of one's own choices and not necessitated by previous events or external factors. Determinists respond that such experiences of freedom are illusions and that introspection is an unreliable and unscientific method for understanding human behavior.

The UNCERTAINTY PRINCIPLE, introduced in QUANTUM MECHANICS by the physicist Werner HEISENBERG, is also thought by some to undermine universal causation. Heisenberg claimed that the scientist is as much a participant as an observer. His work questions whether it is possible to determine an objective framework through which one can distinguish cause from effect, and whether one can know an objective effect if one is always a part of its cause.

Determinism is sometimes confused with PREDESTINATION and fatalism, but it asserts neither that human affairs have been prearranged by a being outside the causal order nor that a person has an unavoidable fate.

Detroit Detroit, Michigan's largest city, is located in the southeastern part of the state. Detroit's population is 1,027,974 (1990), and that of its metropolitan area is



Cartographic Production by Lothar Roth & Associates

4,382,299. The word *détroit* is French and means "of the strait." The city was so named because it is on the west bank of the Detroit River, a strait connecting Lake St. Clair and Lake Erie. Detroit is the seat of Wayne County and covers about 365 km^2 (140 mi^2).

Detroit is known as the Motor City because 25% of the nation's automobiles are manufactured there. It is also a steel-producing center that furnishes both raw metal and finished products for the automotive industry. In addition to the machine-tool and metal-stamping industries closely allied to automobile manufacturing, the Detroit economy relies on industrial chemical plants, drug manufacturing, aircraft manufacturing, aluminum production, and food processing. The opening of the St. Lawrence Seaway (1959) allowed Detroit to become a major port. It is also a major transportation center. The city is connected to Windsor, Ontario, by the Ambassador International Bridge and by a tunnel.

Among the institutions of higher learning are Wayne State University (1868), the University of Detroit (1877),

Detroit's Renaissance Center is a complex of 4 office buildings, a 73-story hotel, restaurants, and shops on the banks of the Detroit River. The 13-ha (33-acre) complex has stimulated some regeneration of the downtown area. Across the river is Windsor, Ontario.

and the Detroit Institute of Technology (1891). The Detroit Symphony is a major orchestra, and there are important art museums, including the Detroit Institute of Arts, the Historical Museum, and the Cranbrook Academy of Art (in Bloomfield Hills). The Detroit Zoological Park is outstanding. Detroit has major league baseball, football, ice hockey, and basketball.

Detroit was founded in 1701 as a frontier trading post and fort by Antoine Laumet de la Mothe CADILLAC. The British captured it in 1760 in the last of the FRENCH AND INDIAN WARS. Detroit was ceded to the United States by JAY'S TREATY (1794). Fire destroyed the town in 1805, but it was quickly rebuilt. It was the capital of the Territory of Michigan from 1805 until statehood in 1837, and it continued as the seat of government until the state capital was moved to Lansing in 1847.

Because of its strategic location, Detroit prospered during the great westward expansion of the first half of the 19th century. The coming of the railroad accelerated the city's growth, and it became a great shipbuilding, shipping, and industrial center. During this same period great numbers of English, Irish, German, and Dutch immigrants settled there.

The automotive industry arrived with the 20th century. Led by such magnates as Henry Ford (see FORD family), William C. DURANT, Walter P. CHRYSLER, and Ransom E. Olds, the industry converted Detroit into the automotive capital of the world. By 1960 it was the fourth largest city in the country, but its population since then has declined. As in most older northern cities, Detroit's inner city was particularly hurt by the movement of the middle class to the suburbs. Massive urban redevelopment programs were initiated with the emphasis on a huge civic center built along the waterfront.

deus ex machina see NARRATIVE AND DRAMATIC DEVICES

deuterium [doo-tir'-ee-uhm] Deuterium, symbol D or ^2H, is the stable, nonradioactive ISOTOPE of HYDROGEN having an atomic weight of 2.014. Its nucleus, the deuteron, consists of one proton and one neutron. Consequently, it has double the mass of an ordinary hydrogen nucleus. Deuterium was first identified (1931) by Harold UREY, F. G. Brickwedde, and G. M. Murphy. Natural hydrogen consists of only 0.015% deuterium. The deuteron is thought to form naturally from protons during the sequence of thermonuclear reactions that convert hydrogen to helium in the Sun and other stars.

Deuterium has a melting point of –254.43° C at 128.5 mm pressure, and a boiling point of –249.49° C. The gas D_2 is slightly less reactive than hydrogen gas, H_2. Deuterium is used as a tracer for elucidating a wide range of reaction mechanisms involving hydrogen in chemical and biological reactions. Heavy water, D_2O, is used as a moderator in nuclear reactors.

deuteron see DEUTERIUM

Deuteronomy, Book of [doot-ur-ahn'-uh-mee] Deuteronomy is the fifth book of the Old Testament in the Bible. Its name, "repeated law" in Greek, is based on the book's stylistic form: a series of speeches in which the law originally given on Mount Sinai is repeated by MOSES to the next generation. The book consists of a double introduction, a legal section with concluding ritual elaboration, two old poems, and an account of Moses' death. Although it is traditionally ascribed to Moses, it could not have been written much earlier than the time of King Josiah (d. *c.*609 BC). However, there was probably an earlier edition of the central legal section dating to the reign of Hezekiah (*c.*700 BC). The principal themes of Deuteronomy include the election of Israel by God, trust in God's power, rejection of foreign gods, and the importance of the Mosaic law.

deutzia [doot'-see-uh] *Deutzia* is the genus and common name of mostly deciduous shrubs belonging to the saxifrage family, Saxifragaceae. There are about 53 species, and except for a few from Central America, all are native to Asia. Some deutzias grow to nearly 3 m (9 ft) tall, and many bear a profusion of white, pink, or lavender flowers in late spring.

Deutzia scabra, *originally from China and Japan, is celebrated for its attractive summer blossoms. The* shrub (bottom) *is about 2–3 m (6–10 ft) tall.*

devaluation Devaluation is an official reduction in the value of a currency in relation to other currencies or to gold. A government usually devalues its currency in order to correct a deficit in its BALANCE OF PAYMENTS. The attempt may succeed if devaluation raises the prices of imports and reduces those of exports in world markets. Investment opportunities in the devaluing country normally improve for foreigners, inviting an influx of foreign capital. Devaluation, however, can lead to further devaluation if persistent payments deficits are not corrected.

From 1945 to 1971, CENTRAL BANKS, in conjunction with the INTERNATIONAL MONETARY FUND, had the responsibility of fixing EXCHANGE RATES. Devaluations were infrequent, but since 1971 a floating exchange-rate system has operated, and values of currencies may move daily upward or downward, except when central banks decide to try to curb fluctuation.

development In biology, development is an all-encompassing term for the changes involved in the formation of a new organism. Most commonly the term is associated with multicellular organisms in which specialized cells, tissues, organs, and systems arise from a single CELL. Certain developmental processes also take place on a microscopic scale, however, in single-celled life forms such as BACTERIA and members of the PROTISTA.

An organism goes through stages of development, whether it reproduces sexually or asexually (see REPRODUCTION). In an organism that reproduces sexually, these steps include fertilization and cleavage of the fertilized egg. All advanced organisms also exhibit later, more complex EMBRYO stages of development, from gastrulation (that is, the beginning of specialized tissues) to the birth of the organism. These more complex stages are discussed in detail under GROWTH, the word *growth* being the general biological term for an organism's increase in mass and size as a result of division of the fertilized egg and its descendant cells.

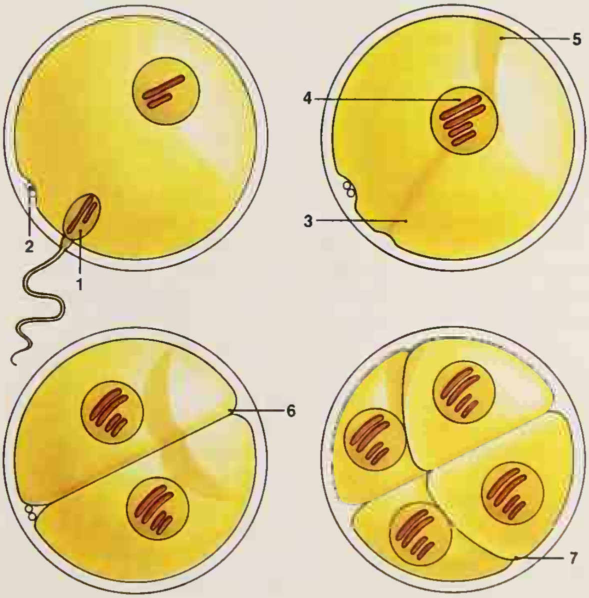
Both of these articles, on development and on growth, deal with physiological development in animals. For a more detailed treatment of the stages of fetal growth in human beings, see DEVELOPMENT, HUMAN. Stages of development observed in other living kingdoms of life are discussed in separate articles (see ALGAE; FUNGI; PLANT).

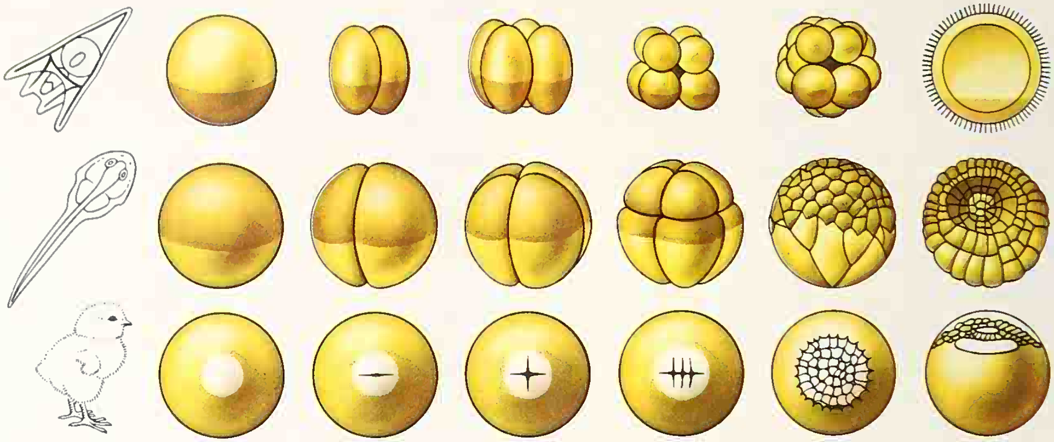
Fertilization

The first stage of development, fertilization, begins when two specialized cells, the EGG and the SPERM, fuse to form a ZYGOTE. The egg and sperm, formed by meiosis, both contain half the number of chromosomes required for development of the individual. Fertilization restores the number to the full, or diploid, value (see GENETIC CODE). When a sperm fuses with an egg, a membrane forms around the egg that prevents additional sperm from fusing with it, thus avoiding formation of a zygote with more than the normal number of chromosomes. The zygote begins to undergo cleavage, or cellular division, by a process known as mitosis.

During the first divisions the zygote does not increase in size. Instead the egg is reduced into smaller parts. By the time 16 cells are formed the zygote has become a solid sphere called a morula. This divides further to form a blastula, a hollow sphere comprising a single layer of cells. A cell produced by cleavage is called a blastomere.

Fertilization of a frog's egg occurs in shallow water. When a sperm (1) *from the male penetrates the egg, the second polar body* (2) *forms. The sperm leaves a trail* (3) *caused by the displacement of granules in a layer of pigment. The nuclei of the sperm and egg fuse, forming a zygote* (4). *Penetration by the sperm includes a shift in the pigment layer, resulting in the formation of a gray crescent* (5) *opposite the point of entry, which determines the first line of cleavage* (6). *Successive divisions* (7) *form a ball of cells.*





After fertilization, an egg divides rapidly and repeatedly, by a process known as cleavage. The form of cleavage varies according to the species of the animal, primarily because of differences in yolk content. (Top) *In the sea urchin, little yolk is present, and cleavage involves the entire egg. The blastula is a hollow sphere with cells of nearly uniform size.* (Center) *A frog egg contains slightly more yolk, which is concentrated primarily in one hemisphere. Following the third cleavage, the less yolky cells* (upper hemisphere) *divide faster and become smaller than the yolky cells* (lower hemisphere), *forming a blastula with cells of uneven size.* (Bottom) *A bird egg contains a large amount of dense yolk that is not divided by cleavage. Only a thin layer of cells cleaves, forming a blastula, known as a blastodisc, that sits on top of the yolk.*

Cleavage

The form of cleavage division varies among animals and depends on the type of egg. Factors influencing cleavage and later development include egg size, amount of yolk present, whether the egg is mosaic or regulative, and polarity.

Egg Size and Yolk. Eggs of invertebrates and primitive vertebrates are small and have little or no yolk. The sea urchin egg, for example, cleaves entirely and, after a number of divisions, produces a blastula of equal-sized cells. The egg of a frog is larger and contains yolk in one hemisphere and almost no yolk in the other. A mass of yolk is difficult to divide, which delays the cleavage process for that portion of the cell. After a period of time there are a few large yolk cells, which serve as a storehouse of food, and a much greater number of small, nonyolk cells. These cells form the frog (tadpole) itself.

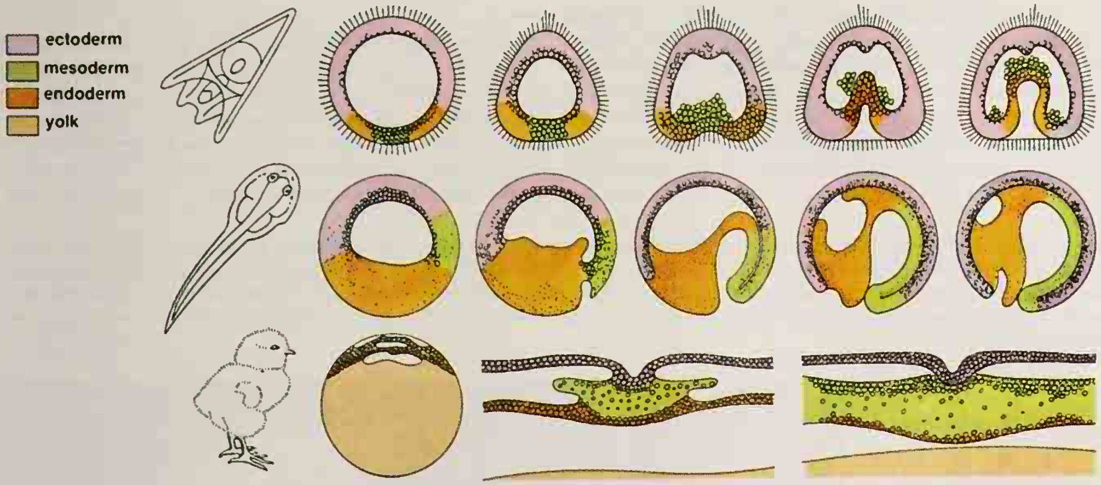
Reptile, bird, and primitive mammal eggs are very large and contain a great amount of yolk. Eggs of higher mammals have little yolk. The embryo develops entirely within the female's uterus.

Yolk is an important source of food for embryos of fish, reptiles, amphibians, birds, and primitive egg-laying mammals. When the developing embryo uses up its supply of yolk, it requires further nutrients from the environment. As a result, eggs with little yolk, such as those of the sea urchin, rapidly hatch into free-living larval forms. While the sea urchin feeds from the environment, it passes through several larval stages and undergoes METAMORPHOSIS before it reaches the final adult form. The embryo of an amphibian, such as a frog, also develops into a larva (the tadpole). The chicken embryo, on the other hand, has sufficient yolk for complete development before hatching. Only a very small amount of yolk is needed in the mammalian egg because the embryo derives nutrients from the mother at an early stage of development.

Mosaic and Regulative Eggs. Each species develops by means of certain cleavage patterns determined by whether the embryo is mosaic or regulative. The developmental potential of blastomeres from a very early mosaic embryo is highly restricted. A blastomere that is removed from a mosaic embryo and grown in culture does not develop into an entire organism but instead into the specific organ or limb that it would have become in an intact embryo. Mollusks, annelids, and coelenterates produce mosaic embryos.

Regulative embryos, such as those of amphibians and mammals, adjust for the loss of an early blastomere so that completely normal, though smaller, adults are produced. The developmental fate of regulative cells is determined much later than that of mosaic cells. As an example, blastomeres of a very early rabbit embryo were removed experimentally and the partial embryo was allowed to develop. The resultant adult rabbit was anatomically complete but was half the size of its parent.

Polarity. Every part of a cleaving zygote potentially has the properties of the whole. This equipotency rapidly disappears with the development of a polar axis, such as that of the head and tail. Polarity determines how the cells of the blastula divide and, later, how the gastrula segments and develops the animal form. In many cases polarity exists in unfertilized eggs, but effects are more commonly seen after a zygote begins to cleave.

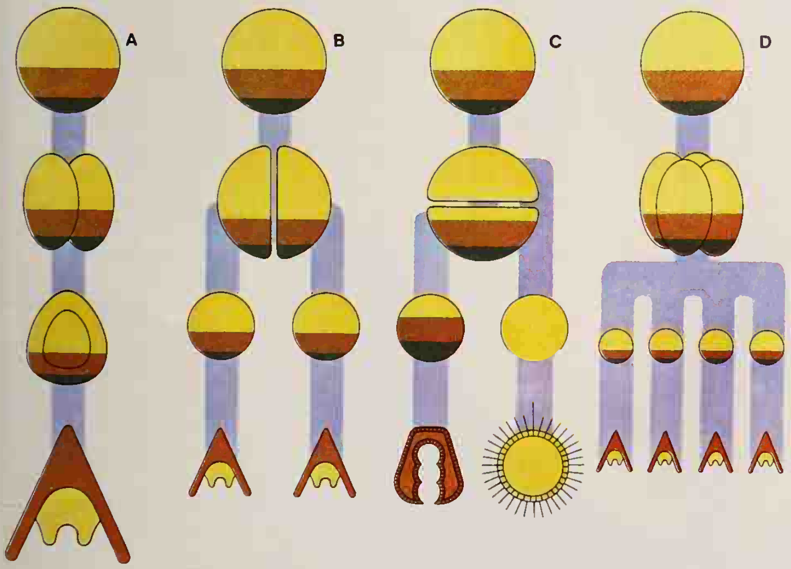


Once cleavage is complete and the blastula has formed, gastrulation begins, during which extensive cell migration occurs. Despite differences in detail among various species, the end result of gastrulation is the same: the formation of three primary cell layers, the ectoderm, the mesoderm, and the endoderm. (Top) *In the sea urchin, cells on one side of the blastula fold inward to form a tubular indentation—the archenteron—while other cells break loose and move inward, becoming mesoderm.* (Center) *A pore, or blastopore, forms on the frog blastula. Cells migrate inward, forming the archenteron and precursors of the three layers.* (Bottom) *The chick blastodisc consists of two layers separated by a cavity. The primitive streak—a blastopore—forms on the top layer, and cells migrate through it to form the mesoderm.*

Later Stages

Once a blastula has formed, the embryo begins to gastrulate, or develop into three primary germ layers, each of which gives rise to specific adult tissues. The germ layers formed are the ectoderm, or outer layer; the mesoderm, or middle layer; and the endoderm, or inner layer. The embryo, now called a gastrula, forms a groove known as the archenteron. Cells from the surface layer, or ectoderm, move into the groove and spread between the surface and the inner layer, or endoderm. These cells form the mesoderm. At the end of gastrulation, each layer begins to form distinct tissues.

Reptile, bird, and mammal embryos develop extraembryonic membranes that surround the embryo and carry out various functions. The innermost membrane, the yolk sac, provides nourishment for the developing organism. One middle layer, the amnion, is filled with saline fluid.

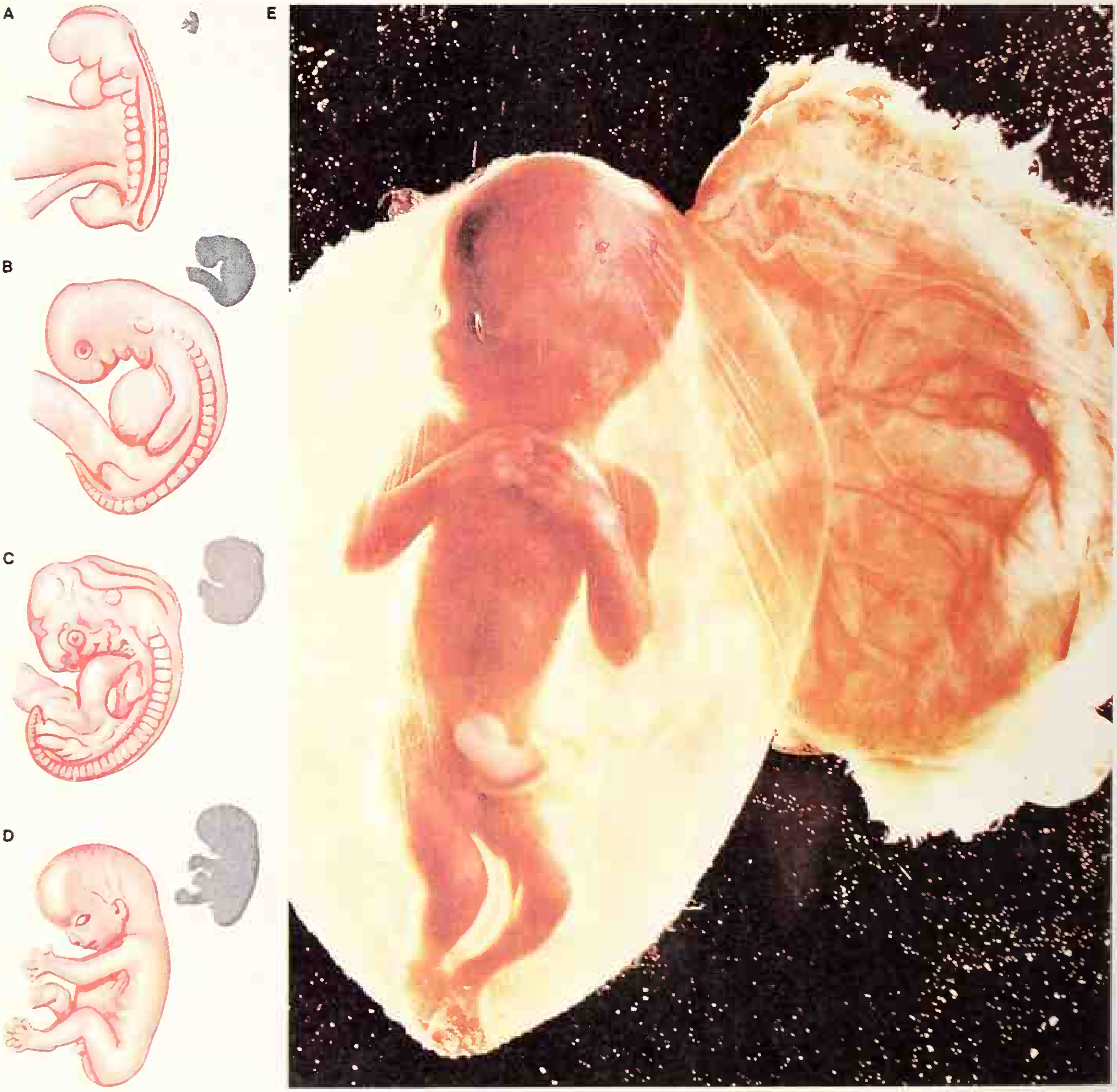


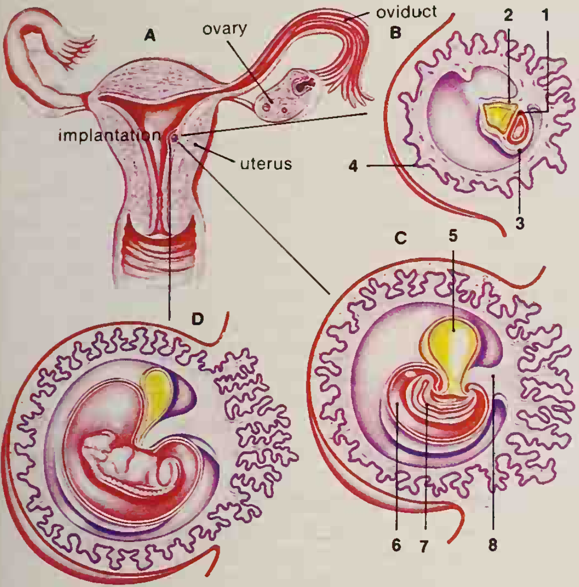
At fertilization, eggs are not uniform in structure because yolk tends to concentrate in one hemisphere, producing animal (less yolky) and vegetal (yolkier) poles. Isolated sections of the eggs of some species can develop into complete embryos, and some early embryos can adjust for the loss of cells. The development of these regulative eggs is governed by genetic material within the nuclei, by the cytoplasm, and by the way the cells are divided. Normal development of a sea urchin (A) *results in a free-swimming multicellular larva, the pluteus. If an unfertilized egg is cut in half from pole to pole* (B), *with both types of material present in each half, and each is then fertilized, normal plutei of small size will develop. If the egg is cut across the equator* (C) *separating the animal and the vegetal halves, abnormal embryos develop, suggesting that the cytoplasm of the egg is not uniform. If cells are removed from an early embryo along the cleavage lines that run from pole to pole* (D), *each will develop into a normal, smaller, pluteus.*

In this way the amniotic cavity protects the embryo against physical shock or extreme temperature changes. The allantois, which is a middle membranous layer, collects excretion from the embryo in lower vertebrates. In mammals the allantois connects to the placenta of the developing fetus by means of blood vessels of the umbilical cord. The chorion is the outermost, protective membrane.

development, human The term *human development*, in biology, includes all of the various biological processes that constitute the formation of a new human being from a single cell. As with other higher animals, every human comes into existence as an egg produced by a female and fertilized by a male (see REPRODUCTION). Humans are also placental MAMMALS. This means that the

After three weeks of growth (A) *the human embryo has a primitive heart and neural tube. Limb buds and rudimentary eyes form by the end of week five* (B) *and become more developed in week six* (C). *By the end of eight weeks, the embryo is called a fetus* (D). *The gray figures beside each drawing indicate actual sizes of embryos. After four months* (E) *the fetus has grown to about 20 cm (8 in) in length and appears more "human." The skin has become thicker and the first hairs appear on the eyebrows and scalp. The umbilical cord, visible in this picture, attaches the fetus to the placenta* (right), *which connects with the mother's circulatory system.*





(A) *The fertilized egg moves through the oviduct to the uterus and begins to implant 7 days after fertilization.* (B) *The inner mass, which later becomes the embryo and surrounding membranes, contains two small sacs of ectoderm* (1) *and endoderm* (2), *surrounded by mesoderm* (3). *The outer ring, or trophoblast* (4), *which will form the placental membranes, is also lined with mesoderm.* (C) *By day 20 the yolk sac* (5) *and the amniotic sac* (6) *appear; the sac surrounds the growing embryo* (7). *The stalk of the allantois* (8) *begins to develop into the umbilical cord.* (D) *By day 28 a rudimentary brain and recognizable features appear. The amnion enlarges as the yolk sac shrinks.*

fertilized egg goes through its stages of DEVELOPMENT and GROWTH inside the mother's womb while attached to her through a vascular region called a placenta. In this way the developing fetus (see EMBRYO) gains nourishment from her circulatory system. This article describes human development from fertilization up through the fully developed fetus ready for birth (see PREGNANCY AND BIRTH).

Fertilization. Fertilization of the EGG occurs inside the female's fallopian tube, or oviduct (see REPRODUCTIVE SYSTEM, HUMAN). Although many of the male's sex cells, or SPERM, are present on the egg's surface during fertilization, usually only one of them penetrates the surface, apparently aided by enzymes it releases. After penetration, the surface of the ZYGOTE, or fused sex cells, becomes resistant to penetration by other sperm.

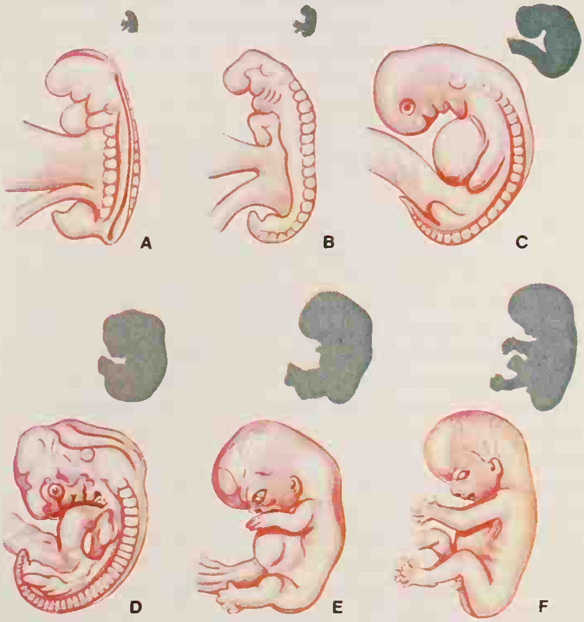
Cleavage and Implantation. The fertilized egg cleaves while it is still in the oviduct. Occasionally the first two cells, or blastomeres, that form upon cleavage separate and the two cells develop independently, resulting in monozygotic twins. If the two blastomeres do not separate completely, SIAMESE TWINS occur, attached to each other by a variable amount of tissue. (See also MULTIPLE BIRTH.)

The zygote develops into a solid sphere of cells, the morula, and then into a blastocyst, which contains a hollow, fluid-filled cavity, the blastocoel. The blastocyst moves through the oviduct, entering the uterus three days after fertilization. At one end of the blastocyst the blastula cells form a thick layer, of which the innermost cells develop into the embryo. The remaining cells form the trophoblast, by which the embryo becomes implanted in the uterine wall. The trophoblast later produces the membranes of the placenta, a tissue that conducts nutrients and waste between mother and embryo. By the second week the blastocyst is completely embedded in the uterus.

The first two membranes to be developed from the trophoblast after implantation are the amnion and the yolk sac. The amniotic cavity contains fluid and eventually surrounds the whole embryo. At later stages of development, the fetus floats in amniotic fluid, which allows it to move freely, protects it from mechanical injury, and provides a stable temperature. The yolk sac, the innermost membrane, is of secondary importance to a human embryo since it depends on the mother's body for nutrition during development. The embryonic cell mass, which lies between the amniotic cavity and yolk sac, divides into the ectoderm, mesoderm, and endoderm.

Ectoderm, Mesoderm, and Endoderm. The ectoderm is responsible for the formation of skin, including hair, nails, teeth, and mammary glands. It also forms the nervous system, including the brain, spinal cord, and nerve cells.

After about 3 weeks (A) *of development, the embryo has a rudimentary heart and a head swelling containing the beginnings of the brain and spinal cord. During the 4th week* (B), *a tubelike heart starts to beat, and 40 pairs of tissue blocks, called somites, appear and begin to develop into muscle, bone, and connective tissue. By the 5th week* (C), *limb buds and eyes are visible. By the 6th week* (D), *limbs enlarge and the tail recedes. After 7 weeks* (E), *the head is enlarged and eyes, ears, fingers, and toes are well defined. By the end of the 8th week* (F) *of development, the embryo is called a fetus. (Silhouettes indicate actual size of the developing embryo.)*



The mesoderm gives rise to the skeletal bones and muscles, circulatory system (heart, arteries, and veins), and urogenital system (kidneys, bladder, and sex organs). It forms a central strip that lies directly under the spinal cord and develops into the rodlike notochord. The mesoderm also forms a broad sheet of cells that divides into three distinct regions, which run alongside the spinal cord. The innermost, thicker mass eventually becomes skeletal muscle and bone. The middle sheet produces the kidneys. The outermost sheets form the muscles and connective tissue of the digestive organs, parts of the lungs, and deeper layers of the skin. On either side of the embryo, underneath the outermost mesoderm, groups of mesodermal cells form small, hollow pockets, which connect and produce a pair of tubes that become part of the circulatory system. As the embryo grows, the tubes fuse, fold, and form the primitive heart. The circulatory tube begins to beat about the 24th day of development.

The endoderm forms a primitive gut, or digestive tube, as well as the inner lining of most of the respiratory system. In a human embryo, the digestive glands make their first appearance as buds along the digestive tube. Although the inner portions of these organs are formed by the endoderm, much of their structure also comes from masses of mesodermal cells.

Umbilical Cord and Placenta. During gastrulation, the embryonic cell mass becomes suspended within the blastocyst by a column of cells that form a connecting stalk. This becomes the umbilical cord. The umbilical cord encloses the remainder of the yolk sac and the allantois, which forms as an extension of the gut. The cord encloses blood vessels that connect the circulatory system of the embryo to that of its placenta. The chorion, the outermost membrane, develops from the trophoblast and mesodermal cells of the embryo. About 12 days after fertilization, it forms fingerlike projections, or villi, which rupture blood vessels lining the uterus so that a food and oxygen supply is established from the mother of the embryo. The chorion develops into the placenta.

Fetal Development. Between 2 weeks and 1 month after fertilization, the eyes, brain, and nervous system begin to form. All the organ systems develop within 60 days following fertilization. After this and until birth 7 months later, development of the human embryo, now called a fetus, primarily involves growth. The fetus weighs about 2 g (0.07 oz) at 60 days and about 3.2 kg (7 lb) at birth.

After about 3 weeks, the heart is beating. About a week later the first limb buds appear. At this point, the embryo has taillike and gill-like structures resembling those of a fish. The structures that resemble gills develop into the upper and lower jaw, and the tail becomes the coccyx of the spine. After 5 weeks the eyes develop, the genital ridge forms, and the limbs enlarge. During the second month, development is explosive. Ears, eyes, fingers, and toes are clearly identifiable, and the sexual organs begin to form.

The testes or ovaries begin to develop after the third month. The genitals develop under the influence of sex hormones, androgens in the male and progesterone and estrogen in the female. The female clitoris and vulva develop from the same tissues that form the male penis and scrotum.

After 4 months, little external change occurs, but internal organs continue to develop. The mother may become aware of fetal movements after 5 months. A 5-month-old fetus reacts to environmental stimuli and turns away from light if it is introduced into the womb. It also sucks its thumb. It grows hair, eyebrows, and eyelashes.

A fetus at less than 24 weeks is unable to live outside the womb. At 26 weeks it may be sustained alive in an incubator, but a fetus born at this time is in danger of respiratory failure, poor temperature control, or both. Significant growth occurs during the 3 months before birth. The final tissues to completely develop are those of the nervous system, especially of the brain. The normal GESTATION period for a human being is 9 months.

See also: GENETICS.

developmental psychology Developmental psychology originally referred to a way of looking at psychology in terms of evolutionary progress. With the growth of new models of psychological development and the decline of the tendency to view change as progress, the term has come to refer to the nonevaluative study of changes in an individual's psychology over time. At first the focus was on changes from birth through adolescence in personality, social behavior, intellectual functioning, and other aspects of behavior. The scope has expanded to include postadolescent periods and even, under the rubric of life-span developmental psychology, through the changes of old age. The predominant focus of developmental psychology, however, is still on children. (See also INFANCY; CHILD DEVELOPMENT; ADOLESCENCE; MIDDLE AGE; OLD AGE.)

Modern developmental psychologists try to describe typical changes occurring in human beings as they age. These may be in the personality as a whole, or in more specific areas such as intelligence, language, or judgments concerning moral issues. Once a typical sequence of changes has been identified, psychologists try to explain it.

Many developmental psychologists approach these changes from a particular theoretical perspective. For many decades in the United States, LEARNING THEORY and PSYCHOANALYSIS were the two dominant perspectives. The former stressed the role of the environment in shaping behavior patterns, whereas the latter focused on factors in early childhood that presumably affected the development of the adult personality. On this account, later characteristics of an individual's personality result from the manner in which early life crises, such as weaning and toilet training, are resolved. In the past quarter-century, followers of Sigmund FREUD, such as Erik ERIKSON, have modified and developed these earlier views to take into account social and historical factors.

A third perspective, however, has assumed a major role: the cognitive developmental approach (see COGNITIVE PSYCHOLOGY). This approach explains changes in terms of underlying sets of mental operations of systems of rules. It is particularly reflected in the work of Jean PIAGET and his collaborators, but is also found in the work of Heinz Werner, Henri Wallon, and others. The Piagetians and critics inspired by their work have provided detailed studies of the development of the object concept, spatial notions, and the concepts of time and causality.

Since the 1950s the work of Soviet psychologist Lev Semyonovich Vygotsky (1896–1934) has been increasingly influential. Containing both behavioral and cognitive elements, one of Vygotsky's major contributions has been the concept of "zone of proximal development," according to which psychological development depends on outside social forces as much as on inner resources. The contribution of adult "tutors" is crucial to a child's development.

deviance The terms *deviance* and *deviant behavior*, as generally used, refer to behavior that departs from an accepted standard or norm. Norms have been devised and maintained by every society throughout history as a way to regulate the behavior of its members. Accordingly, certain actions are considered unacceptable when they are in violation of the rules. Because norms vary from society to society, behavior that is considered deviant in one society may be acceptable and common in another. Deviant behavior excites disapproval or condemnation of, or hostility toward, the persons who engage in it.

Behaviors deemed deviant in American society would include such criminal acts as rape, murder, drug addiction, and prostitution, and also homosexuality, which many consider morally offensive, if not criminal. Conditions such as mental illness, handicaps, and ugliness are also sometimes socially disvalued to the point of being regarded as deviant.

In the past, studies of deviance focused on the characteristics—social and psychological—of individuals who committed disapproved actions. More recent research has included the study of reactions to socially disapproved behavior, and the investigation of why societies set up certain rules and why some rule violators are punished when others are not.

Deviance is a matter of degree. The greater the number of people who condemn a given action, the more deviant it is. The more power the people who disapprove of a given action have, the greater its chances of being punished. Last, the more extreme or intense the negative reaction a given act touches off, the more deviant it is. Behavior that generates a mild negative reaction from a few, relatively powerless individuals is barely deviant. Behavior that generates a strong negative reaction from many, relatively powerful individuals may be regarded as strongly deviant. Society's reaction may be expressed by official and authorized personnel, in which case the deviance is codified into law and overlaps with CRIME. Disapproval may also take the form of stares, ridicule, gossip, exclusion, or avoidance.

The character of the negative reaction to deviance depends not only on the behavior itself and on who observes it, but also on who engages in it and the circumstances surrounding the act. For example, there is less disapproval of adults who engage in premarital sex than there is of adolescents who engage in the same activity. Likewise, the context in which the act is embedded tempers response to it. For example, there is greater tolerance for public drunkenness on New Year's Eve than at other times.

See also: CONFORMITY; NORM, SOCIAL.

devil see DEMON; SATAN

devilfish see STINGRAY

Devil's Island Devil's Island (French, Île du Diable) is part of the French overseas department of FRENCH GUIANA. One of the three Îles du Salut (Safety Islands), it lies in the Atlantic Ocean, 13 km (8 mi) from Cayenne on the coast of South America. Low and rocky, it covers about 39 km^2 (15 mi^2). Established as part of the French Guiana penal colony in the 1850s, it became notorious for its unhealthful tropical climate and for the cruel treatment of prisoners. Alfred Dreyfus (see DREYFUS AFFAIR) was imprisoned there in 1895. France made plans to abolish the penal colony in 1938 and completed the removal of prisoners early in the 1950s.

Devil's Tower National Monument Devil's Tower National Monument in northeastern Wyoming is the nation's first national monument, proclaimed on Sept. 24, 1906. Located beside the Belle Fourche River, the majestic tower of columnar rock rises 264 m (865 ft) with a base diameter of 300 m (1,000 ft). Shaped like a gigantic tree stump, its flat peak has an area of about 0.6 ha (1.5 acres). The tower is most likely the lava neck of an extinct volcano. The Sioux called the tower Mateo Tepee, or "Grizzly Bear's Lodge," because legend claimed that the columns of the rock were created by the claws of a bear trying to climb the sheer walls to catch some Indians on top.

Devolution, War of The War of Devolution between France and Spain started in 1667 when LOUIS XIV claimed that Spanish possessions in the Low Countries had "devolved" on him through his wife, Marie Thérèse, sister of CHARLES II of Spain. The French overran (1667) the Spanish Netherlands, but the formation (January 1668) of the TRIPLE ALLIANCE by the Dutch, English, and Swedes induced Louis XIV to accept the Treaty of AIX-LA-CHAPELLE (May 1668), by which France retained parts of Flanders and Hainaut.

Devon [dev'-uhn] Devon (also called Devonshire) is a county in southwestern England, bordered by Bristol Channel on the north and the English Channel on the south. It covers 6,711 km^2 (2,591 mi^2) and has a population of 1,021,100 (1988 est.). EXETER is the county town and an important industrial and transportation center. Agriculture is the economic mainstay of Devon; livestock raising, dairy farming, and fruit and grain cultivation are carried on. Tourism is also important because of the mild climate, coastal resorts including Torbay, and national parks of Dartmoor and Exmoor. PLYMOUTH is the leading port. Inhabited before the Bronze Age, Devon was part of the Anglo-Saxon kingdom of WESSEX.

Devonian Period see EARTH, GEOLOGICAL HISTORY OF; GEOLOGIC TIME

dew Dew is atmospheric moisture that condenses on objects, usually at night. The condensation takes place on objects that are colder than the dew-point temperature of the surrounding atmosphere. That is, air can hold only a certain percentage of moisture, depending on its temperature and pressure. When it is cooled, locally, to the point where it is saturated, it deposits its moisture. This point is called the dew point. The ground dampness formed when a warm, moist wind blows over cold earth is also considered dew.

DEW line see BMEWS

Dewar, Sir James [doo'-ur] The Scottish chemist and physicist Sir James Dewar, b. Sept. 20, 1842, d. Mar. 27, 1923, invented the Dewar flask, better known in its home use as the thermos bottle. In 1891 he invented a method for producing large quantities of liquid oxygen, and in 1892 he invented the double-walled flask separated by a vacuum to keep the liquid oxygen cold. In 1898, Dewar became the first person to liquefy hydrogen. With F. A. Abel he also developed cordite, the first practical smokeless gunpowder.

Dewey, George George Dewey, b. Montpelier, Vt., Dec. 26, 1837, d. Jan. 16, 1917, was an American naval officer who defeated the Spanish fleet at Manila Bay in the Philippines during the SPANISH-AMERICAN WAR. A member of the U.S. Naval Academy class of 1858, Dewey served under David Glasgow FARRAGUT during the Mississippi River campaigns of the Civil War. He had risen to the rank of commodore by November 1897, when he was ordered to command the Asiatic Squadron. Spurred by the aggressive assistant secretary of the navy Theodore Roosevelt, Dewey planned his assault on Manila well before war erupted. His descent upon Manila harbor on May 1, 1898, left the Spanish fleet in ruins and paved the way for occupation of the city of Manila by the U.S. Army and Navy on August 13.

During the siege, Dewey antagonized the Filipino nationalist Emilio Aguinaldo, who shortly thereafter led the bloody insurrection against the United States. Dewey also became suspicious of the observing German naval commander, Otto von Diederichs. Returning to a hero's welcome in the United States, Dewey was promoted to admiral and made president of the navy's general board. In that position he oversaw formulation of the naval war plans against Germany and Japan. He remained on active duty as the navy's senior officer until his death.

Dewey, John John Dewey, b. Burlington, Vt., Oct. 20, 1859, d. June 1, 1952, was one of 20th-century America's most influential educators and philosophers. He graduated from the University of Vermont in 1879 and received his Ph.D. from Johns Hopkins University in 1884. He was initially drawn to German philosophy, especially the unifying, organic character of HEGEL's idealism.

After teaching at the University of Michigan (1884–94), Dewey became chairman of the department of philosophy, psychology, and pedagogy at the University of Chicago in 1894 and while there wrote the classic *The School and Society* (1899), formulating the method and curriculum of the school in which the child's growth is the central concern. He reached the height of his influence as a professor at Columbia University from 1904 to 1930, during which time he wrote for the general public on social problems and the critical issues confronting American industrial democracy, participated in many liberal causes and civic organizations, and helped found the NEW SCHOOL FOR SOCIAL RESEARCH (1919) in New York City.

In his first book, *Psychology* (1887), Dewey attempted to combine his philosophical idealism with G. Stanley HALL's new physiological psychology. After the appearance of William JAMES's *Principles of Psychology* (1890), some seminal articles by Charles Sanders PEIRCE (*Monist*, 1891–93), the impact of Darwinism, and the work of George Herbert MEAD, however, Dewey's psychological writings changed; the spiritual Self was reconceived in social and behavioral terms. His paper "The Reflex Arc Concept in Psychology" (1896) was a primary source of functional psychology, which views stimulus and response as functional and correlative means of organic coordination and direction. The implications and applications of this view were developed by Dewey in *How We*

John Dewey, an American pragmatic philosopher and progressive educator, appears in this painting by Edwin B. Child. Dewey's advocacy of learning by experimentation and experience had a profound effect on the methods and theories of 20th-century American education.

Think (1910) and *Democracy and Education* (1916), the latter a major statement of his philosophical and educational doctrines that stimulated the PROGRESSIVE EDUCATION movement in the 1930s.

Dewey's works on psychology, ethics, and social philosophy analyze the logical features of thought and action. Thought is occasioned by problematic conditions, organic imbalance, and conflict; thoughtful action is directed toward resolution and is thus instrumental in producing truth, which is the warranted and satisfactory solution of a problem. This "instrumentalism" was Dewey's version of the pragmatism he shared with James and Peirce.

PRAGMATISM was then the most influential philosophy in the United States, and this aspect of Dewey's thought was advanced in *Essays in Experimental Logic* (1916), *Human Nature and Conduct* (1922), and *Logic: The Theory of Inquiry* (1938). He discussed the experimental theory of intelligent conduct, or inquiry, present in ethical and aesthetic kinds of experience in *Ethics* (with J. H. Tufts, 1908), *Theory of Valuation* (1939), and *Art as Experience* (1934).

Dewey's philosophy attempts to show how scientific conclusions affect the values guiding human conduct. This is perhaps best seen in *Experience and Nature* (1925), in which he formulates an extensive naturalistic theory of existence that requires no supernatural assumptions or conclusions. The range and diversity of Dewey's writings, together with his effect on 20th-century philosophy, aesthetics, education, legal and political theory, and the social sciences, place him among the great philosophers.

Dewey, Melvil American librarian Melvil Dewey, born Melville Louis Kossuth Dewey in Adams Center, N.Y., on Dec. 10, 1851, d. Dec. 26, 1931, is best known as the inventor of what came to be called the Dewey Decimal System of Classification, used in most local and school libraries to catalogue books. Devised in 1876 as a system for small libraries, it has the advantage of a limited number of general categories and short call numbers. The system is based on ten classes of subject (000–999), which are then further subdivided. Dewey also promoted the use of the metric system, helped found the American Library Association in 1876, and edited *Library Journal* (1876–81) and *Library Notes* (1886–98). When Dewey created Columbia University's School of Library Economy in 1887, he began the field of library science in the United States.

DEWEY DECIMAL SYSTEM

000–090	Generalities
100–190	Philosophy and related disciplines
200–290	Religion
300–390	Social sciences
400–490	Language
500–590	Pure sciences
600–690	Technology (applied sciences)
700–790	The arts
800–890	Literature
900–990	Geography and history
Language	
400–409	Language
410–419	Linguistics
420–429	English and Anglo-Saxon languages
430–439	Germanic languages—German
440–449	French, Provençal, Catalan
450–459	Italian, Romanian, Rhaeto-Romanic
460–469	Spanish and Portuguese languages
470–479	Italic languages—Latin
480–489	Hellenic languages—Classical Greek
490–499	Other languages

Dewey, Thomas E. Thomas Edmund Dewey, b. Owosso, Mich., Mar. 24, 1902, d. Mar. 16, 1971, was a governor of New York State and a nationally influential Republican. He graduated from the University of Michigan in 1923. After receiving his law degree at Columbia University, he worked for well-known New York City law firms and began participating in politics. In 1935 he was appointed special prosecutor to investigate organized crime in New York City and became prominent for the number of his convictions.

In 1937, Dewey was elected district attorney in New York County. He ran as the Republican candidate for governor of New York four consecutive times, beginning in 1938, and was elected in 1942, 1946, and 1950. He also won the Republican presidential nomination twice (1944, 1948), but was defeated by the incumbent presidents Franklin Roosevelt and Harry Truman. Dewey was efficient, honest, and hardworking, although not a magnetic leader. He was supported by the liberal internationalist wing of his party. After his service as governor, Dewey retired and pursued a profitable legal practice in New York City.

Dewhurst, Colleen An actress, Colleen Dewhurst, b. Montreal, June 3, 1926, d. Aug. 22, 1991, was especially noted for her performances in Eugene O'Neill's plays, one of which, *A Moon for the Misbegotten*, won her the 1974 Tony Award. In 1961 she received a Tony Award for her acting in *All the Way Home*. She also won acclaim for her Shakespearean and modern roles.

dextrose see CARBOHYDRATE; SUGAR

Dhahran [dah-rahn'] Dhahran (Arabic: az-Zahran) is a town in northeastern Saudi Arabia (1988 est. pop., 46,500) about 15 km (9 mi) from the Persian Gulf. Near the site of the first oil discovery in Saudi Arabia, the town is the administrative headquarters of the Arabian American Oil Company (Aramco) and is the site of the King Fahad University of Petroleum and Minerals (1963). Also a military base, it came under Iraqi missile attack in the 1991 GULF WAR.

Dhaka, or Dacca, located in the Ganges deltaic area, is the capital and largest city of Bangladesh. The city grew in importance during the 17th century as an administrative center of the Mogul Empire.

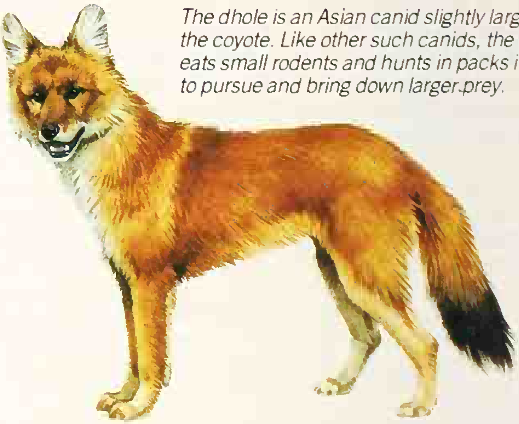
Dhaka [dak'-uh] Dhaka (formerly Dacca) is the capital and largest city of Bangladesh. It is located in the geographic center of the country in the great deltaic region of the Ganges and Brahmaputra rivers. The population is 4,770,000 (1987 est.). Dhaka is served by the port of Narayanganj, to the southeast.

Dhaka is located in one of the world's leading rice- and jute-growing regions. Its industries include textiles (jute, muslin, cotton) and food processing. The Muslim influence is reflected in the more than 700 mosques and historic buildings found throughout the city. Dhaka is divided into an old city, a modern section called Ramne, and many residential and industrial communities. The University of Dhaka (1921) and several museums are located there.

Dhaka was founded during the 10th century. It served as the Mogul capital of Bengal from 1608 to 1704 and was a trading center for British, French, and Dutch interests before coming under British rule in 1765. In 1905 it was again named the capital of Bengal, and in 1956 it became the capital of east Pakistan. The city suffered heavy damage during the Bangladesh war of independence (1971). The romanized spelling of the Bengali name was officially changed to Dhaka in 1982.

dharma [dahr'-muh] In Hinduism, dharma refers to the moral law, the religious and ethical duties of an individual. Following one's dharma entails conduct appropriate to one's CASTE and fulfillment of Hindu precepts. The carrying out of dharma is said to govern one's rebirths. Hinduism itself is called sanatana dharma (eternal dharma), or everlasting law. In Buddhism, dharma is the body of truth taught by Buddha.

dhole [dohl] Dholes, *Cuon alpinis*, are members of the DOG FAMILY, Canidae. Although doglike in appearance, they are not classified with the true dogs, genus *Canis*, differing in such features as number of molars and having 12 to 14 nipples instead of 10. The dhole is often called the Indian dhole, but varieties also exist in Siberia, Malaysia, and Indonesia. Dholes have red to brown coats, may be as long as 1 m (3 ft), and are relatively short-legged. Like many other canids, the animals hunt in packs when seeking larger prey.



The dhole is an Asian canid slightly larger than the coyote. Like other such canids, the dhole eats small rodents and hunts in packs in order to pursue and bring down larger prey.

di Suvero, Mark [dee-soo'-vur-oh] Mark di Suvero, b. Shanghai, China, Sept. 18, 1933, an American artist, is known for his monumental sculptures that evoke, in three-dimensional form, the gestural statements of abstract expressionist painting. Di Suvero emigrated to the United States in 1941, studied philosophy and sculpture in California, and moved to New York in 1957. His early work was strongly expressionistic until the 1960s, when he began making sculptures from weathered wood, scrap metal, machine parts, and other junkyard objects. His sculptures are often meant to be touched, swayed, and even crawled on. Numerous examples are at the Storm King Art Center, Mountainville, N.Y.

dhow [dow] see SHIP

Diabelli, Anton [dee-ah-bel'-lee] Anton (Antonio) Diabelli, b. Sept. 6, 1781, d. Apr. 7, 1858, an Austrian of Italian descent, was a composer, music publisher, and teacher. While he was a choirboy in Salzburg, Michael Haydn was his musical mentor. In 1803 he went to Vienna, where he taught piano and guitar. His piano sonatinas are still played by beginning students, but he gained immortality as the result of his 1819 invitation to noted composers of the day to write variations on a little waltz he sent them—a form of promotion for his publishing house. Beethoven's belated response was the massive, towering *Diabelli Variations* (1823).

diabetes *Diabetes* is a term used for two different endocrine diseases, both of which are characterized by excessive urination and thirst. Diabetes mellitus is a pancreatic disease affecting carbohydrate, protein, and lipid metabolism. In severe diabetes mellitus, the concentration in the blood of a sugar, glucose, is markedly elevated and large amounts of glucose are excreted in the urine. Diabetes insipidus is a condition associated with the inability of the kidney to conserve water. It is caused by a failure of the hypothalamus to release antidiuretic hormone. The discussion in this article is limited to diabetes mellitus, which is a far more prevalent and important disease than diabetes insipidus. (See ENDOCRINE SYSTEM, DISEASES OF THE.)

Incidence. Diabetes mellitus affects more than 10 million people in the United States and causes about 300,000 deaths each year. Its prevalence increases with age from about 0.1% for persons under 17 years of age to about 8% for persons aged 65 years and over. Diabetes is more common in females and, in the United States, is inversely related to family income. The prevalence of diabetes varies markedly among ethnic groups. It is virtually unknown in the Alaskan Eskimo, for instance, but may occur in up to 50% of elderly Pima Indians. In the United States its prevalence is approximately 20% higher in non-Caucasians than in Caucasians.

Types of Diabetes Mellitus. Diabetes mellitus is due to an inability of the PANCREAS to secrete sufficient INSULIN to maintain a normal blood-glucose concentration. Secondary diabetes results from damage to or removal of the pancreas. Primary diabetes, the most common type, is probably caused by both environmental and genetic factors (see AUTOIMMUNE DISEASES).

The insulin-dependent form of primary diabetes generally has its onset in childhood and is characterized by severe insulin deficiency. Without insulin, the diabetic will develop ketoacidosis (high levels of ketone bodies in the blood, causing lowered blood pH and possible heart failure) and coma (caused by very high levels of blood glucose).

The non-insulin-dependent form usually occurs in obese people of age 40 or older. They have higher-than-normal levels of insulin, although the insulin is less effective in lowering blood glucose than in nondiabetics, and they rarely develop ketoacidosis. This pattern is also seen in the Pima Indians and some other groups that have adopted Western processed-food diets. With each pregnancy, women also slightly increase their risk of developing the condition.

Diagnosis and Treatment. A variety of methods may be used to diagnose diabetes mellitus. In the glucose tolerance test, for example, abnormal glucose metabolism is identified by having a patient who has fasted for 18 to 24 hours drink a concentrated solution of glucose; glucose concentration is then measured in blood and urine samples taken ½, 1, 2, and 3 hours after ingestion. The most reliable diagnostic methods detect a blood-glucose concentration greater than 140 milligrams per decaliter (normal is 70–100 mg/dl) after an overnight fast. Also, the presence of 64K ANTIBODY has proved a good predictor of insulin-dependent diabetes.

After the isolation of insulin by Frederick G. BANTING and Charles BEST in 1921, death from ketoacidosis and diabetic coma decreased dramatically. The prolonged life span revealed long-term complications, however, including kidney failure, atherosclerotic heart diseases, blindness, and disorders of the nervous system. These complications are believed to be related to elevated blood-glucose concentrations. The objective of diabetes treatment, therefore, is to restore blood glucose to normal. In obese non-insulin-dependent diabetics the treatment of choice is weight loss. If this method does not suffice, then oral hypoglycemic agents or insulin is required. Oral hypoglycemic agents act primarily by stimulating the patient's pancreas to secrete additional insulin.

Insulin-dependent diabetics traditionally have been treated with one or two daily injections of slowly absorbable insulin. This mode of insulin therapy, however, results in poor control of the blood glucose. To mimic the closely linked changes in blood glucose and insulin concentrations that occur in healthy nondiabetics, new techniques for insulin delivery have been developed in which insulin is either injected with a syringe or infused using a small pump under the skin prior to each meal. Low insulin concentrations are maintained between meals by injecting a long-acting insulin preparation or by infusing insulin continuously. An oral insulin preparation is also undergoing clinical trials.

Diadochi [dy-ad'-uh-ky] The Greek word *Diadochi*, meaning "successors," designates the first generation of successors to ALEXANDER THE GREAT (d. 323 BC). Chief among them were ANTIGONUS I, ANTIPATER, DEMETRIUS I POLIORCETES, LYSIMACHUS, PERDICCAS, PTOLEMY I, and SELEUCUS I (d. 281 BC).

Diaghilev, Serge Pavlovich [dyah'-gil-yif, syirgay' pahv'-luh-vich] Serge Pavlovich Diaghilev, b. Perm, Russia, Mar. 19 (N.S.), 1872, d. Aug. 19, 1929, creator of the legendary BALLETS RUSSES DE SERGE DIAGHILEV, was unquestionably one of the greatest impresarios in BALLET

The Russian ballet impresario Serge Diaghilev, shown here in a sketch by Picasso, created a brilliant, unique amalgam of dance, art, and music in the productions of his company, the Ballets Russes. Diaghilev directed his legendary company from 1909 until his death in 1929.

history. Diaghilev and a group of friends, including the painters Léon BAKST and Aleksandr Benois, founded the art journal *Mir Iskusstva* in 1899, which continued publication until 1904. Under imperial patronage Diaghilev took a sumptuous exhibition of Russian art to the Petit Palais in Paris in 1906.

He returned to Paris in 1907, presenting five concerts of Russian music at the Opéra, where in the next year he mounted the Western premiere of Modest Mussorgsky's *Boris Godunov*, with Fyodor Chaliapin in the title role. Finally, on May 19, 1909, his newly formed Ballets Russes, consisting almost entirely of Russian émigrés, made its debut in Paris and achieved instant immortality. For the next 20 years, until Diaghilev's death, the company presented about 68 ballets, including many that are still in the repertoire of world ballet. Among them are *The Firebird* (1910), *Petrushka* (1911), *The Rite of Spring* (1913), *Parade* (1917), *The Good-Humored Ladies* (1917), *Apollo* (1928), and *The Prodigal Son* (1929). Except for an opulent production of Peter Ilich Tchaikovsky's *Sleeping Princess* (1921) in London, Diaghilev avoided full-length classic ballets in favor of new, shorter works that he had commissioned. For these he employed some of the greatest artists of the 20th century, including the painters Pablo Picasso and Henri Matisse, the choreographers Mikhail FOKINE and George BALANCHINE, the dancers Alexandra DANILOVA and Vaslav NIJINSKY, and the composers Sergei PROKOFIEV and Igor STRAVINSKY.

diagnosis see EXAMINATION, MEDICAL

diagnostic tests A diagnostic test is used to identify a disease. Such tests help a physician decide between alternative diagnoses or confirm a diagnosis made by other means, such as symptom analysis or direct physical examination (see EXAMINATION, MEDICAL). Hundreds of diagnostic tests are available, based on physiological, immunological, and biochemical principles and on an understanding of what is normal and what is not.

Tests Performed on the Patient. Some diagnostic tests are performed directly on the patient. The most basic is the use of the STETHOSCOPE to discern disorders of the heart and lungs. Skin tests are used for such various purposes as determining the cause of an allergy or finding out whether a person is susceptible to or has contracted an infectious disease. Other tests performed directly on the patient include liver, kidney, and THYROID FUNCTION TESTS, in which the ability of those organs to clear the blood of injected substances is measured. PULMONARY FUNCTION TESTS require a patient to perform a series of breathing tests.

Tests Performed in the Laboratory. A number of diagnostic tests are performed entirely in a laboratory and are based on the analysis of body fluids, such as blood, urine, cerebrospinal fluid, gastric contents, sputum, semen, and fluids aspirated from body cavities. A large clinical laboratory usually includes hematology, chemistry, serology, urinalysis, microbiology, and radiology departments. In the hematology department, the quantity and form of blood cells are examined for abnormalities (see BLOOD TESTS). In the chemistry department, measurements are made of organic and inorganic constituents of body fluids and, sometimes, of such materials as hair and fingernails. Compounds measured include glucose, urea, and proteins. Inorganic substances measured include sodium, iron, and calcium. Chemical tests are also used in the urinalysis department, particularly to find the presence of blood, drugs, or high levels of body products in URINE. The physical properties of urine are also analyzed, including its volume, specific gravity, and color. The serology department specializes in examining the immunologic properties of body fluids. Serological tests can reveal the previous or current presence of such infectious diseases as SYPHILIS and an immunologic incompatibility between the blood of a mother and that of her developing fetus. Tests for GENETIC DISEASES have been developed as well. In the microbiology department, body fluids and other body products are cultured to identify pathological organisms and to determine to which antibiotics they are most susceptible. FECES are examined for parasites. In the RADIOLOGY department, CAT scanners and other machines are used to examine internal organs or defects without surgery. A rapid test for antigens, called a RADIOIMMUNOASSAY, was developed in the 1970s.

Hospitals also have anatomical pathology departments. Tissues taken during a biopsy or from deceased patients (see AUTOPSY) are studied to determine the presence of specific diseases.

Another development is the growing use of home medical tests. Kits are now available for a wide range of conditions, although many physicians have expressed concern over the possibilities created for wrong or incomplete diagnoses.

dialect see GEOGRAPHICAL LINGUISTICS

dialectic In LOGIC, *dialectic* generally refers to a process of critical reasoning. ARISTOTLE's *Topics* was the first systematic account of dialectic. PLATO conceived of dialectic primarily as question and answer, and as the critical dialogue one has with one's soul. In the 18th century Immanuel KANT used the term *dialectic* systematically in his CRITIQUE OF PURE REASON, arranging the four contradictions of pure reason as four sets of thesis and antithesis. Johann Gottlieb FICHTE, followed by Friedrich Wilhelm Joseph von SCHELLING, applied the term *synthesis* to the third stage of resolving the contradictions in the thesis and antithesis. This triadic concept, which characterizes the usual meaning of the term *dialectic* today, was advanced and elaborated by Georg Wilhelm Friedrich HEGEL and Karl MARX. For Hegel, dialectic is a threefold process in a rational and spiritual reality. In Marx's theory, known as DIALECTICAL MATERIALISM, dialectic describes the processes of social change in a material world.

dialectical materialism Dialectical materialism is a synthesis of MATERIALISM and the dialectic developed by G. W. F. HEGEL. It is materialist in that it denies transcendence and affirms the ultimate reality of the physical world, beyond which nothing exists. Thus all phenomena, including human behavior, are regarded as having their origins in the material universe. Change is viewed as the result of the interaction of opposites. Each thing that exists (thesis) gives rise to its opposite (antithesis); the interaction of thesis and antithesis is ultimately reconciled (synthesis) to become a new thesis. Karl MARX and Friedrich ENGELS used these assumptions to analyze and explain historical development. They saw human actions as motivated by the material, particularly the economic, circumstances of the individual and interpreted history as the interaction of economic forces.

dialogue see NARRATIVE AND DRAMATIC DEVICES

Dialogues of Plato Plato's *Dialogues* use the Socratic question-and-answer method as the author's dramatic means of expounding the philosophy of his teacher Socrates or of advancing his own views. Each dialogue takes place in ancient Athens, and the main character of each is Socrates. Through the medium of discussion with a character who initially espouses an opposing point of view, Socrates presents his case for the importance of ethical standards—as opposed to scientific truth—and urges his disciples to seek perfection of soul, not for the sake of wealth or fame but for the sake of virtue itself. Through knowledge, claims Socrates, humans can discern objective standards of conduct that are universally applicable. Plato's most famous dialogues include THE REPUBLIC, *Apology, Crito,* and *Phaedo.*

dialysis [dy-al'-i-sis] Dialysis is the separation of dissolved substances, particularly large molecules from smaller ones, using the ability of some membranes to allow certain substances to pass through them and to prevent the passage of others. Such membranes are said to be semipermeable (see MEMBRANE CHEMISTRY; OSMOSIS).

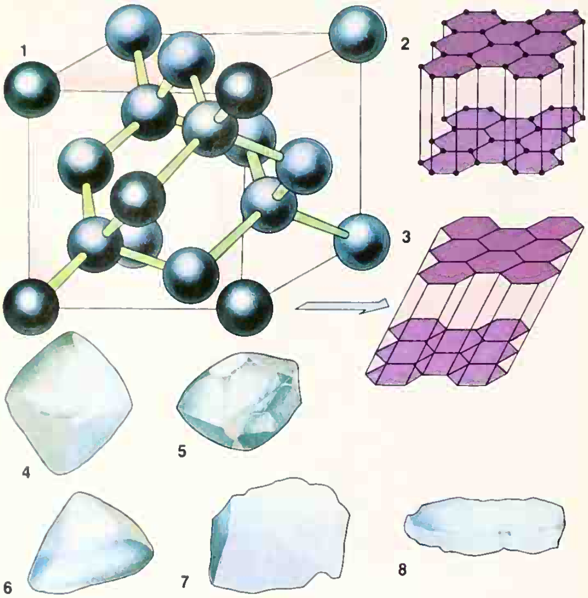
The phenomenon was first reported in 1861, when a parchment membrane was used to separate sucrose from gum arabic. Today most dialysis tubing is made from regenerated cellulose. This material does not pass substances with molecular weights above about 10,000, a class that includes most proteins and the nucleic acids. To separate such a substance from salts or other compounds of low molecular weight, a solution of the mixture is put inside a bag formed by tying the tubing at both ends. The bag is suspended in water, which is repeatedly changed and discarded; the dialyzable substances pass into the water and are gradually eliminated.

Membranes can be made that are permeable to either positive or negative ions, and the passage of ions through the membrane can be speeded by applying an electrical potential across it. This process is called electrodialysis and has been used on a large scale to produce drinkable water from brackish water or seawater; in most cases, however, alternative methods of removing salt have proved more economical.

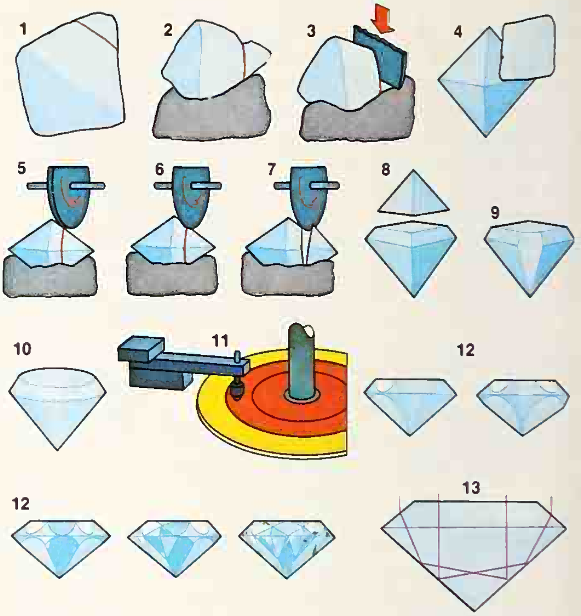
In medicine, dialysis can be used when the kidneys fail to function as a means of removing toxic waste products from the blood; this process is called hemodialysis. Artificial kidneys have been devised for this purpose (see KIDNEY, ARTIFICIAL).

diamond Diamond is pure, natural carbon with the atoms organized in a close-packed cubic arrangement that gives the stones their hardness. Because it is so much harder than any other natural or artificial substance known, diamond is ideal for both gem and industrial purposes. Special optical properties guarantee its preeminence among gems. First, its high refractive index (2.417), or light-bending ability, enables it to throw back almost all the light that enters a well-cut gem. This gives rise to the gem's brilliant, or adamantine, luster. Second, it exhibits strong dispersion (0.058), or the ability to sep-

A rough, uncut diamond (left) *resembles a dull piece of glass with a distorted, octahedral shape. A diamond gem* (right), *with its characteristic sparkle and fire, is obtained by skillful cutting, grinding, and polishing of the stone's flat facets.*



Diamonds and graphite are different forms of carbon. The carbon atoms in a diamond are linked in a rigid tetrahedral arrangement (1), *resulting in a hard material. Graphite, which is extremely soft, consists of hexagonal rings of carbon atoms in weakly bonded, parallel layers* (2) *that can slide* (3) *easily over each other. Depending on its shape, a mined diamond is classified as a regular unbroken stone* (4), *a less regular unbroken* shape (5), *a twinned, roughly triangular* macle (6), *an irregular broken* cleavage (7), *or an irregular parallel-sided* flat (8).



The production of a finished diamond gem involves marking the cleavage plane (1), *grooving the mark* (2), *and using a steel blade* (3) *to cleave the stone into an octahedron shape* (4). *A thick saw* (5) *and then a thin saw* (6, 7) *are used to cut the stone in the desired form* (8), *the top edges of which are ground into a circular shape* (9, 10). *A rotating wheel* (11) *coated with different grades of diamond powder is used to grind and polish the numerous facets* (12), *which give the finished diamond* (13) *its brilliant reflective properties.*

arate the various colors of the spectrum. This causes the gem to throw back the bright flashes of separated colors ("fire") for which it is particularly noted.

Gemstones

Fewer than 20 percent of the diamonds mined each year are suitable for use as GEMS. These stones are finished in various kinds of cuts, or "make." The best proportioned ones throw back the most light. No universal standards have been adopted for "make," but the American Standard Brilliant Cut is the closest to ideal proportions. Finished stones are graded according to quality and then marketed. Various classification systems—based on color, clarity (freedom from flaws and inclusions), cut, and carat weight—are used to determine quality and, thereby, the market value of gem diamonds. The largest single rough diamond, the Cullinan diamond, found in 1905 in South Africa, weighed 3,106 CARATS. A total of 105 gems were cut from it.

Industrial Uses

Industry uses most uncut diamonds. Diamond-studded rotary bits are used to drill oil wells and bore tunnels in solid rock. Much low-grade diamond is crushed to dust, sorted by grain size through special sieves, and used as abrasive powder. Depending on the kind of abrasion or grinding needed, the powder is either sintered into metal disks, formed in carbide grinding wheels, pressed into metal, or mixed in an oil paste. The powder is also used to cut and polish gems. Diamond-tipped glass cutters, glass-etching pencils, and other similar tools find widespread use. Very thin wire is formed by pulling thick wire through a graduated series of diamonds with tiny holes drilled through them. Diamonds for industrial purposes are synthesized using high-temperature, high-pressure, and shock-wave techniques.

Technological uses for diamonds were expanded in the late 1980s by the development of methods for depositing diamond coatings on surfaces. Such uses include the coating of INTEGRATED CIRCUITS as a whole instead of having to cool the components individually. The coatings may also be used in prosthetic devices and biosensors.

Mining and Production

Diamonds occur in two general types of deposits: volcanic pipes through which molten rock—KIMBERLITE, now cooled and hardened—rose up from deep within the Earth, and PLACER DEPOSITS, which were formed by the erosion of diamond pipes over millions of years. Microscopic diamonds have also been discovered in METEORITES, where they are thought to have been produced by the tremendous explosions of ancient SUPERNOVAS.

The earliest productive mines were in the Golconda region of India. After 1725 this region was gradually eclipsed by deposits in Brazil, where diamonds were first mined in the state of Minas Gerais. In 1867 a great diamond rush started in South Africa when a 21-carat stone was discovered on the banks of the Orange River near Hopetown. Another major diamond resource was developed in the 1950s in the Yakutia region of the Soviet Union. By the late 1980s, Australia, with a huge new mine near Lake Argyle, had joined the southern African nations and the Soviet Union in dominating the world's diamond market.

Diana In Roman mythology Diana was originally a forest and woodland deity to whom the hind and the cypress were sacred. Later, she was identified with the Greek goddess ARTEMIS and was known as an ardent huntress, patron of women, and chaste goddess of the moon.

Diane de Poitiers [dyahn duh pwah-tyay'] Diane de Poitiers, b. Sept. 3, 1499, d. Apr. 22, 1566, was the mistress of HENRY II of France. Beautiful, intelligent, and cultured, she exercised great influence over the king, who totally neglected his wife, CATHERINE DE MÉDICIS. Diane was a patron of many artists and poets, including Pierre de RONSARD.

diaphragm see HUMAN BODY

diarrhea [dy-uh-ree'-uh] Diarrhea is the passage of frequent, more or less fluid stools. It is not a disease, but it is a sign of an underlying disorder. Diarrhea can be a reaction to certain foods, excessive alcohol consumption, cathartics, infections, or emotional problems. It may also be a symptom of a serious disease such as ulcerative COLITIS or cancer of the colon. Diarrhea is dangerous in infants because it can rapidly lead to dehydration.

The two basic mechanisms involved in diarrhea, which may operate independently or together, are excessive accumulation of fluid in the intestinal tract and excessive propulsive action in the intestines. Excessive fluid in the intestines can result from conditions that decrease the absorption of water from the colon, causing osmotic diarrhea, or from conditions that cause water to be secreted into the intestines, as in cholera and other infections (see DYSENTERY). Excessive propulsive action may be caused by nervous or chemical factors or by partial obstruction of the intestine. Drugs may relieve distress in mild cases, but a physician should be consulted if severe diarrhea lasts more than two days.

diary A *diary*—frequently interchangeable with the term *journal*—is a day-to-day record of events, ranging from personal to public. Diaries may be intimate, such as Jonathan SWIFT's *Journal to Stella*, or anecdotal, such as those of Samuel PEPYS and Samuel SEWALL.

Dias, Bartolomeu [dee'-uhsh,bar-tu-lu-may'] Bartolomeu Dias, d. May 1500, was a Portuguese navigator whose discovery (1488) of the Cape of Good Hope showed Europeans there was a route to India around Africa. Dias's expedition of three ships was financed by the Portuguese king JOHN II. Dias took part in the expedition of Pedro Álvares CABRAL that discovered Brazil, but his ship sank en route.

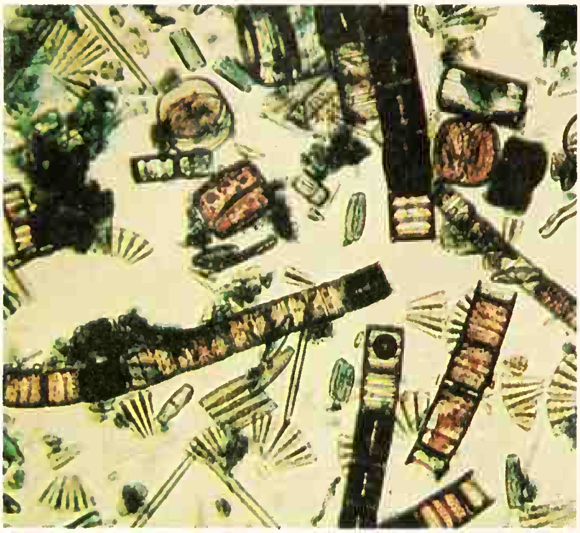
Diaspora [dy-as'-puh-ruh] Diaspora, a Greek word meaning "dispersion," refers to the various Jewish communities outside Palestine. Settlements of Jews were established in ancient Babylon and Egypt as a result of commerce and exile after the destruction of the Temple in 586 BC (see BABYLONIAN CAPTIVITY); others developed throughout the Mediterranean after the Jewish revolts against Rome in the 1st and 2d centuries AD led to further dispersion. Local synagogues provided focal points in lieu of the distant Temple of Jerusalem. Today the term *diaspora* is still used to designate the settlements of Jews outside of the modern Jewish state of Israel.

diathermy [dy'-uh-thur-mee] Diathermy is a medical procedure for producing heat locally or diffusely in a patient by using a high-frequency electric current. There are two types: surgical and medical. In surgical diathermy the current is concentrated through a small point, which destroys the cells it touches. Outside the immediate area the cells are not harmed because the current rapidly spreads out. Surgical diathermy is used to cut and coagulate tissue or to destroy tumor cells. In medical diathermy less-intense heat is produced over a larger area. The heat increases the blood supply to a region and thus strengthens the defensive processes of the body.

diatom [dy'-uh-tahm] Diatoms are one-celled golden-brown ALGAE of the division Chrysophyta. They are a prominent component of freshwater and marine PLANKTON and are among the primary photosynthetic producers of organic materials in the oceans. The diatoms' walls are impregnated with silica and hence are glasslike, often giving the cell a jewellike appearance.

When diatoms die, they sink and form deposits of diatomaceous earth. This material is used in preparing such commercial products as detergents, fertilizers, insulating and soundproofing materials, polishes, and paint removers. Much petroleum is also of diatom origin.

The diatom cell wall consists of two overlapping halves. In asexual reproduction, cell division occurs, and each half of the original parent becomes the upper half of each daughter cell. A new lower half is formed inside each of the two halves of the parent cell walls. The daughter cell receiving the lid of the parent is like the parent in size, whereas the other daughter is slightly smaller. The continued diminution in size is halted eventually, when the small cells form auxospores that expand



Diatoms are microscopic, one-celled plants found in all water puddles, streams, and oceans. This 37.5× magnification of marine diatoms reveals some of the thousands of existing forms and the characteristic glasslike cell walls.

to the original size.

Most diatoms are autotrophic; that is, they produce their organic nutrients from inorganic materials through photosynthesis. Some are heterotrophic, obtaining organic nutrients from the environment and storing food in fatty deposits within the cell. Most diatoms are sedentary, and only certain species—the so-called pennate diatoms—are capable of moving at all. Most diatoms live singly; others form loose aggregations joined by a sheath material secreted from their pores.

Díaz, Porfirio [dee'-ahs, por-feer'-yoh] Porfirio Díaz, b. Sept. 15, 1830, d. July 2, 1915, was a Mexican general and dictator who dominated Mexico from 1876 to 1911. The son of a mestizo family of modest means, Díaz originally studied for the priesthood but changed to law. He abandoned his studies in 1854 to join the revolution that overthrew Santa Anna. Thereafter he dedicated himself to a military career and rose in the ranks during the Wars of the Reform (1858–61). He became a general in 1861, and in the same year he was elected as a federal deputy from the state of Oaxaca. During the French intervention (1861–67), Díaz fought with the republican forces under Benito Juárez, eventually commanded an army, and was instrumental in the eventual success of the republican army and the overthrow of Maximilian's empire. In 1871, Díaz rebelled against the government to prevent Juárez's reelection but was defeated.

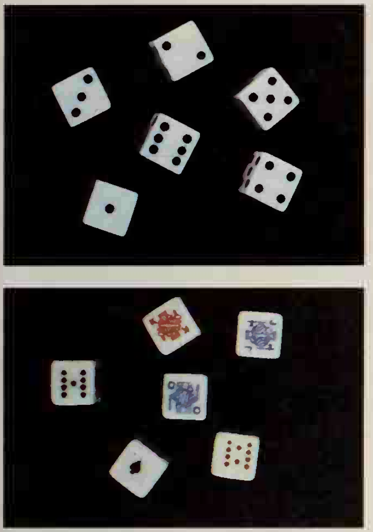
He rebelled again in 1876, opposing Juárez's successor, Sebastián Lerdo de Tejada. This time he was successful, and as a result he became president (1877), a position he held, except for the 1880–84 term, until 1911. Díaz fostered economic growth but ignored the resulting social problems. Catering to wealthy Mexicans and foreign businessmen, Díaz's government helped take land from the Indian peasant communities and tried to suppress the growing labor movement. He also tried to eradicate banditry by using a state police force called the *rurales*. In 1909, Díaz announced that he would reinstate democracy, but in 1910 he once again tampered with the election, alienating Mexicans of all social classes. The result was a revolution led by Francisco Madero, which drove Díaz from power in 1911. He died in exile in Paris.

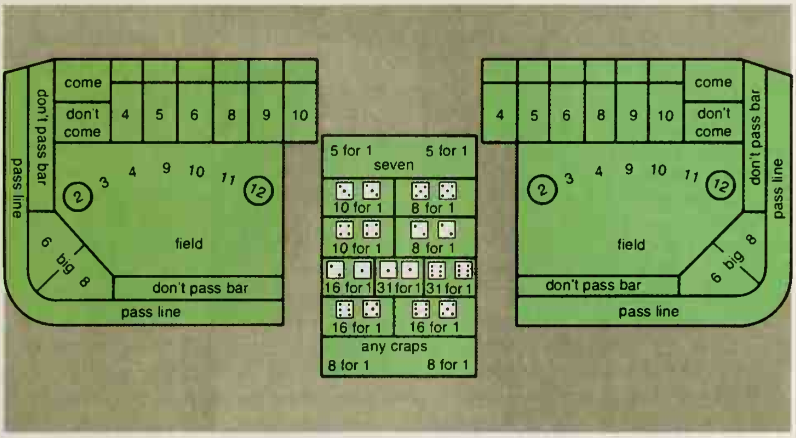
Porfirio Diaz, a Mexican general, was formally elected president of Mexico in 1877, several months after he had seized power in a coup. Under his dictatorial rule, Mexico experienced economic growth but at the expense of the peasants and laborers. A revolution led by Francisco Madero forced Diaz from power in 1911.

Diaz de la Peña, Narcisse Virgile [dyahs day lah payn-yah', nar-sees' vir-zheel'] Narcisse Virgile Diaz de la Peña, b. Aug. 20, 1808, d. Nov. 18, 1876, was a French painter of Spanish descent and a member of the Barbizon school of landscape artists. Much of his work has classical overtones, as in *Nymphs and Amorini* (1857; Louvre, Paris), but his best works from 1840 onward depict scenes in the Forest of Fontainebleau.

dice games Dice, the oldest gaming instruments known to humankind, are used in countless board games and are an integral tool in many gambling games. The modern game of craps, which uses two dice, developed from an old English game called hazard. In informal craps play, any number of players form a ring around the playing surface. The first player (the shooter) to roll the dice places a bet that he or she will win; every other player may place bets that he or she will lose. The general rule regarding the first roll is that any one of five numbers settles the bets immediately; seven or eleven, and the shooter wins; two, three, or twelve, and the shooter loses. Any other number becomes the shooter's point; if it is rolled before a 7 appears, the shooter wins and continues to roll. If the shooter "sevens out," a new shooter takes over.

The casino game of craps, a favorite in the United





All six sides of ordinary dice (upper) *and poker dice* (lower) *are shown at left.* (Above) *This "double sided" layout for bank craps is typical of those found in most casinos. The odds against a player making his point are 251 to 244 at the start of the game.*

States, is played on a felt-surfaced rectangular table on which a layout, or diagram, shows all possible bets and house odds on each layout. The table is surrounded by a wall, approximately 30 cm (12 in) high, and the dice must be thrown so as to hit the wall and bounce back.

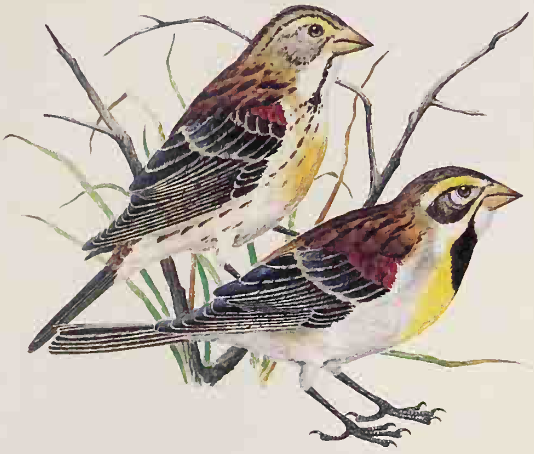
Chuck-a-luck, another popular gambling house game, is played with three dice. In its simplest form the roller bets on a single number only. If the number shows up on one die, the roller collects the amount bet. If it appears twice, the payoff is double; if on all three, triple.

Poker dice calls for five dice (often bearing playing card denominations), and any number may play. A player may roll the dice once, twice, or three times in an attempt to get the best possible poker hand. In liar dice, the players then declare their hands. A player may declare any hand, and the player to the left must either accept the statement or call the declarer a "liar." If the accused's hand is as good as or better than declared, the accuser must throw a unit of bet in the pot. If the statement is accepted as true, the player on the left becomes the roller. The game (and pot) is won when only one player has a unit of bet left.

dichroism see OPTICS; POLARIZED LIGHT

Dick, Philip K. The work of science-fiction writer Philip Kindred Dick, b. Chicago, Dec. 16, 1928, d. Mar. 2, 1982, reflects his interest in the nature of belief and of psychological reality. His characters are not heroic, and a troubled doubt underlies his frequent humor. Dick received science-fiction awards for *The Man in the High Castle* (1962), a fantasy about society had Hitler won World War II, and *Flow My Tears, the Policeman Said* (1974), a study of drug effects. *Do Androids Dream of Electric Sheep?* (1968) was made into the film *Blade Runner* (1982).

dickcissel [dik-sis'-ul] The dickcissel, *Spiza americana*, a bird of the finch family, Fringillidae, is related to and resembles the sparrow. It nests in the eastern and midwestern United States and normally winters in Central and South America. The male is distinguished from sparrows by its yellow breast with black V-shaped band. Females have distinctive throat markings and may show yellow on the breast.



The dickcissel migrates south from the eastern and midwestern U.S. in autumn. The male has a black breast patch; the female has streaks running from throat to tail.

Dickens, Charles Charles Dickens, b. Portsea, England, Feb. 7, 1812, d. June 9, 1870, was a popular Victorian novelist, now regarded as one of the greatest English writers. His novels combine vast social panoramas, deep compassion for the lower class, melodramatic

Charles Dickens wrote some of the greatest novels of Victorian England. Drawing on his own youthful experience of poverty, Dickens portrayed the grim life of an increasingly industrialized England and the corruption in London. In his social commentary, however, Dickens achieved impact through humorous caricature.

intensity and pathos, and comic exuberance.

Life. Dickens was born into a family whose genteel aspirations were thwarted by his father's carelessness with money. When Dickens was 12 his father, John, was imprisoned for debt, an event that Dickens considered the most terrible experience of his life. Removed from school and put to work in a blacking (shoe-dye) factory, he lived alone, ashamed and frightened, in a lodging house in North London.

Dickens eventually returned to school, but his financial difficulties were not over. When he was 15 he went to work as a clerk in a law firm. Later he became a reporter, first of dull law cases and then of parliamentary debates, experiences that were to shape his social consciousness. Like the title character of David Copperfield (1850), Dickens was a phenomenally quick stenographer. An acute observer with a dedication to hard work, he began writing comic-pathetic sketches that revealed his talent for focusing on eccentricity of character. These sketches were first collected in *Sketches by Boz* (1836).

Works. Dickens's success began with *The Posthumous Papers of the Pickwick Club* (1836–37), now known as *The Pickwick Papers*. Invited to write the narrative to accompany a series of sporting sketches drawn by Robert Seymour, Dickens objected to his subordinate position and forced Seymour out, replacing him with Hablot K. Brown ("Phiz"), who remained Dickens's primary illustrator for more than 20 years.

Dickens's energy was evident throughout his career. While writing *Pickwick* he became editor of a monthly magazine, *Bentley's Miscellany*, which he made instantly successful. When *Oliver Twist* (1837–39) was being serialized in *Bentley's*, he was editing a biography of the clown Joseph Grimaldi. With *Oliver Twist* half completed, he began monthly installments of *Nicholas Nickleby* (1838–39).

In 1836, concurrently with the composition of *Pickwick*, Dickens married Catherine Hogarth, and the couple had ten children. The marriage was, however, deeply unhappy and complicated by the premature death of Catherine's sister, Mary, for whom Dickens had a strong affection; by his love affair with the young actress Ellen Ternan, purported to be the model for the heroines in his later novels; and by his commitment to the reading public and the public performance of his works. Dickens separated from Catherine in 1858.

In March 1840, Dickens started a weekly periodical, *Master Humphrey's Clock*, in which he published *The Old Curiosity Shop* (1840–41) and *Barnaby Rudge* (1840–41). In book form (1841), *The Old Curiosity Shop* achieved a circulation of over 100,000. Beginning with A Christmas Carol (1843), Dickens published annual Christmas stories. In 1850 he established the weekly journal *Household Words*, which became *All the Year Round* in 1859. At the same time that he was involved in editing, writing for, and controlling these journals, Dickens continued to write novels and helped to establish a home for reformed prostitutes and to press for slum clearance, education reform, sanitary measures, and the numerous social issues reflected in his works.

As early as *Oliver Twist*, Dickens's concern about modern society was evident. His early works implied faith in the new commercial middle class as opposed to the old aristocracy. As the first great urban novelist, however, he saw the failures of the business ethic. While remaining capable of presenting the comic face of a tragic world, Dickens grew disenchanted. When he began to address social issues directly, as in *Dombey and Son* (1848), and to organize his novels around clear themes and dominant images, many lamented the loss of the warmhearted co-

Dickens' Dream, *by Robert William Buss, portrays Dickens in a creative reverie, bringing to life the exuberant variety of characters that populate his novels.*

median of *The Pickwick Papers*. The image of a corrupt judicial system presiding through a vast fog pervades *Bleak House* (1853), often regarded as Dickens's masterpiece, although not his most popular work. In *Little Dorrit* (1857) the prison haunts almost every character. *Our Mutual Friend* (1865), Dickens's last finished novel, expresses increasing disillusionment.

When Dickens died, with his last novel (*The Mystery of Edwin Drood*, 1870) still incomplete, he was an embittered man. He is, however, remembered as an author successfully committed to bringing joy into the bleakness of urban life. In works ranging from *Hard Times* (1854), a satire of Victorian education and a portrayal of the ugliness of factory life, through A TALE OF TWO CITIES (1859), which depicts the excitement and chaos of revolutions, to GREAT EXPECTATIONS (1860–61), a sensitive study of a boy's development into a man, the power of his novels grows from their capacity to record accurately and yet remake the world, to transform the ordinary into something magical.

Dickey, Bill William Malcolm Dickey, b. Bastrop, La., June 6, 1907, was a baseball player. An outstanding catcher for the New York Yankees from 1928 to 1946, he played with the Yankees in eight World Series (1932, 1936–39, 1941–43), seven of which his team won. Dickey finished with a lifetime batting average of .313, batting more than .300 in 11 of 17 seasons; in four seasons, he had more than 100 runs batted in. He also hit 202 career home runs. Briefly in 1946, Dickey was Yankee manager. He was elected to the Hall of Fame in 1954.

Dickey, James A major American poet, James Lafayette Dickey, b. Atlanta, Ga., Feb. 2, 1923, is best known for his novel *Deliverance* (1970; film, 1972). It is the story of four city-bred men who take a raft trip down a wild Southern river only to encounter savagery and death.

Dickey served in World War II and Korea as a bomber pilot, and the experience informs some of his best poems: "The Performance," from *Into the Stone and Other Poems* (1960), and "The Firebombing," from *Buckdancer's Choice* (1965), which won the 1966 National Book Award. Flight is also a central symbol in Dickey's second novel, *Alnilam* (1987), and the themes that are prominent in his poetry—the war, family, nature—appear again in this work. From 1966 to 1968, Dickey was consultant in poetry to the Library of Congress.

Dickinson, Edwin Edwin Dickinson, b. Seneca Falls, N.Y., Oct. 11, 1891, d. Dec. 2, 1978, was a portraitist and landscape painter, in whose work details often dissolve in a flickering light. He is a superb draftsman whose designs and carefully controlled elongations are inspired in part by El Greco's work. Frequently, as in *Woodland Scene* (1929–35; Andrew Dickson White Museum, Ithaca, N.Y.), the juxtaposition of thematically unrelated objects—an old woman, a female nude, and fire in the underbrush—creates a mood of haunting mystery related to surrealism.

Dickinson, Emily Emily Elizabeth Dickinson, b. Amherst, Mass., Dec. 10, 1830, d. May 15, 1886, was, with Walt Whitman, one of the two foremost American poets of the 19th century. Dickinson was born of an old Connecticut River valley family, and her grandfather, her father, Edward, and her older brother Austin served as treasurers of Amherst College and in many other civic positions. There was little, however, in this middle-class family, ruled by the austere, authoritarian father, to anticipate the bold, concentrated, imaginative force of the second of the three children.

Dickinson graduated from Amherst Academy in 1847 and attended nearby Mount Holyoke Female Seminary for one year, returning home shaken by the attempts to persuade her to join the Congregational church. Longing for a secure faith and Puritan by temperament, Dickinson was nevertheless unable to make a profession of faith.

The life of the imagination became an alternative commitment. She was steeped in Ralph Waldo Emerson's essays; Emerson's transcendentalism, in its optimistic affirmation of God's immediate, benevolent presence in nature and in the soul, provided a response to Calvinistic predestination. By 1858 she had copied out some of her early poems, collecting them in small, sewn packets. In the early 1860s she underwent a profound psychological and emotional disturbance, which biographers have tried to connect with a tragic, unrequited love. Whatever its source, the crisis stirred her imagination and brought her to poetic maturity. During the years 1862–66 she produced more than a third of her poetry.

In April 1862 she wrote to Thomas Wentworth Higginson, a popular critic, asking for advice about her poems. Their originality in form and content—irregular rhythms adapted from hymn meters, slant rhymes, eccentric phrasing and syntax, and emotional intensity and candor—led him to advise against publication. Though keeping Higginson as a correspondent, she continued to write poems in the same style. By the late 1860s, in-

Emily Dickinson, one of the finest and most original American poets of the 19th century, wrote aphoristic poetry of unusual concentration, power, and impact.

creasingly withdrawn from contacts beyond the family circle, Dickinson had become a recluse, dressing always in white. But the sentimental stereotype of Dickinson as a frail, injured spinster has given way to the recognition that her seclusion was a deliberate choice made to secure independence for her vocation: living out her inner life unflinchingly in her tightly packed poems.

The facts of her external life reveal little to spark comment: friendships, mostly through correspondence; devotion to her parents until their deaths, to her younger, unmarried sister Lavinia, and to her brother Austin, whose unhappy marriage was a strain on all the family; and finally, a reciprocated love for Judge Otis P. Lord, a widowed friend of her father, which came too late for marriage. What Dickinson gained through renunciation is enacted in the contradictory moods of her poetry. The nature pieces range in tone from an Emersonian sense of wonder to a feeling of alienation akin to that of Poe or Melville. Her responses to God run the gamut from coy submission to rebellious defiance.

Fearing she would be misunderstood, Dickinson published only seven poems during her lifetime, confident of posthumous fame. During her final decades she never left her house and garden, but among her papers was a scrap that read, "Area—no test of depth." Since her death, she has come to be hailed as perhaps the greatest woman poet since Sappho.

Dickinson, John John Dickinson, b. Talbot County, Md., Nov. 8, 1732, d. Feb. 14, 1808, was an American Revolutionary pamphleteer and member of the Continental Congress. After studying law in London, he became a preeminent trial lawyer in Philadelphia. Elected to the Pennsylvania legislature in 1762, he joined the conservatives defending the proprietary system against critics such as Benjamin Franklin. Active in the colonial protest against British policies, he attended the Stamp Act Congress (1765) where he advocated commercial retaliation. His widely read *Letters from a Farmer in Pennsylvania to the Inhabitants of the British Colonies* (1768) vigorously defended colonial rights while urging conciliation.

In the Continental Congress, Dickinson agreed to the necessity of armed resistance only after the Battle of Lexington. He helped draft the Articles of Confederation, was a member of the military committee of Congress, and served briefly in the army. In 1783 he helped establish Dickinson College in Pennsylvania. He was an active participant in the Constitutional Convention of 1787 and led the fight for ratification of the Federal Constitution in Delaware.

Dickinson, Jonathan A Presbyterian minister and educator, Jonathan Dickinson, b. Hatfield, Mass., Apr. 22, 1688, d. Oct. 7, 1747, was a leading preacher in the GREAT AWAKENING. He was a prominent Calvinist theologian and a champion of religious freedom. In the dispute occasioned by the Great Awakening, he sided with the prorevivalists and helped form the enduring pattern of American Presbyterianism. Dickinson was pastor at Elizabethtown (now Elizabeth), N.J., from 1709 to 1747 and was one of the founders and first president of the College of New Jersey (now Princeton University).

Dickson, Brian Robert George Brian Dickson, b. Yorkton, Saskatchewan, May 25, 1916, served (1984–90) as 15th chief justice of Canada. He succeeded Bora Laskin. Appointed to the post by Prime Minister Pierre TRUDEAU, who had first named Dickson to the Supreme Court of Canada in 1973, he was considered a moderate liberal. Dickson, who received a law degree from Manitoba Law School in 1938, had practiced and taught law in Manitoba before being appointed to the Court of Queen's Bench of Manitoba in 1963.

dicot see ANGIOSPERM; COTYLEDON

dictatorship A dictatorship is a form of government in which authority is centered in a single person whose power is neither circumscribed by law nor by the acts of other official bodies. In ancient Rome the dictator was a special magistrate appointed to rule in times of emergency. Many modern dictators have also come to power in difficult times. They either seize or are granted extraconstitutional powers, claiming as justification the need for strong executive leadership. The dictator's power usually stems from control over key institutional bases of power, such as a political party, the police, or the army.

By its nature, dictatorship is an unstable form of government. No provision can be made for a successor to the dictator, and the consequence may be a series of dictators who seize power by coups, a prolonged struggle between rivals, or a bloody civil war.

dictatorship of the proletariat In MARXISM, the dictatorship of the proletariat is a transitional stage in the establishment of a communist state. It is the point at which the workers (proletariat), after destroying the capitalist system and abolishing private property, institute collective ownership of the means of production. The dictatorship is theoretically temporary, and it will ultimately wither away, to be replaced by the final stage, a classless society.

dictionary A dictionary is a list of words and phrases that is arranged alphabetically and gives the pronunciation, alternate spelling, and meaning of each entry. Many dictionaries also explain the origin of each word, state what part of speech it is, and indicate how it is used idiomatically. More detailed dictionaries supply additional information, including the chronological development of each word. Bilingual and polyglot dictionaries include at least some of these details and add the equivalent foreign words. Encyclopedic dictionaries give additional information on substantive topics and include the names of people and places. There are also specialized dictionaries of many kinds, including dictionaries arranged by word roots, dictionaries of synonyms, dictionaries of special subject areas, dictionaries of dialect or jargon, and reverse indexes, in which words are arranged by their terminations.

Early History. Early examples of dictionaries have survived from classical Greece, many being glossaries of difficult words in Homer's poems. The first recognizable general dictionary was compiled by Marcus Verrius Flaccus about 20 BC; no copy survives, but part of Sextus Pompeius Festus's abridgement (late 2d century AD) of his *De verborum significatu* (On the Meaning of Words) is extant and quotes extensively from the earlier work of Flaccus. The advantages of alphabetical arrangement were well known to the Greeks and Romans, but it was rarely used in dictionaries until the 10th- or 11th-century Greek encylopedic dictionary called *Suidas*. In China the earliest dictionary, the *Shuo Wen*, was compiled AD *c.*100.

Later History. A part of Vincent of Beauvais's encyclopedia, the *Speculum maius* (The Greater Mirror), first completed in 1244, was devoted to a glossary—a feature copied by Pierre Bercheure in his *Reductorium, repertorium et dictionarium morale utriusque testamenti* (*c.*1340), the first work to use the word *dictionary* for this purpose. Merchants, scholars, exiles, translators, and travelers needed bilingual dictionaries. Some early printed examples are the *Vocabolista italiano-tedesco* (Italian-German Vocabulary, 1477) and the *Vocabulary in French and English* (*c.*1483) of William Caxton.

Scholar-printers accelerated the development of dictionaries: the renowned Estienne family compiled and published about 20 Greek and Latin dictionaries during the 16th and 17th centuries. Between 1591 and 1612 the Italian academies made valuable contributions, and the Accademia della Crusca issued its *Vocabolario* (1612), the first of the great national dictionaries. This spurred Cardinal Richelieu to set up the Académie Française in 1634, which produced the first edition of the French national dictionary in 1694. Most earlier dictionaries had been arranged by the roots of words, but the second edition (1718) of the Académie's dictionary was arranged alphabetically, and this system gradually grew in popularity.

Modern History. Before the 18th century, many types of words, such as slang, technical terms, and dialectal words, were omitted from dictionaries. John Harris's *Lexicon Technicum* (1704) devoted considerable space to defining technical and scientific words. About the same time, polyglot dictionaries, sometimes covering seven or eight languages, appeared, and missionaries began to compile dictionaries of Oriental languages. The Spanish academy's multivolume dictionary appeared in 1726–37, and the first British dictionary that could claim international reputation, the *Dictionary of the English Language*, was issued in 1755 by Samuel Johnson. Pronunciation was first given due emphasis in James Buchanan's *Linguae Britannicae* (1757).

The work of Noah Webster, *An American Dictionary of the English Language* (1828), achieved immediate and lasting success in both North America and Britain. In France, Pierre Larousse issued a series of important dictionaries, and Emile Littré compiled his *Dictionnaire de la langue française* (1873–78), notable for its etymologies and examples of usage drawn from famous authors. The brothers Jacob and Wilhelm Grimm compiled the *Deutsches Wörterbuch*, the great German dictionary that was begun in 1854 and not completed until 1960. In Sir James Murray's, *A New English Dictionary* (1888–1928), now known as *The Oxford English Dictionary* (*OED*; 2d ed., 1989), the history of every word is clearly demonstrated. By this time, interest in the history of language had developed greatly: Frédéric Eugène Godefroy issued his huge *Dictionnaire de l'ancienne langue française* (1881–1902), Eelco Verwijs and Jacob Verdam's *Middelnederlandsch Woordenboek* (1885–1912) was issued at The Hague, and Johan Fritzner's *Ordbog over det gamle Norsk sprog* (1886–96) appeared in Norway.

The 20th Century. The 20th century has proved the most productive and innovative period in the history of dictionaries. There are now dictionaries of slang, of dialects, of individual periods in the history of a language; dictionaries of comparative philology; and dictionaries of ancient and only recently deciphered languages. Many dictionaries are compiled with the help of computers and are available in electronic format.

Diderot, Denis [dee-der-oh', duh-nee] The reputation of the French philosopher, author, and critic Denis Diderot, b. Oct. 5, 1713, d. July 31, 1784, was based during his lifetime primarily on the *Encyclopédie*, a huge undertaking that occupied him as chief editor for a quarter century and was to become a milestone of the French Enlightenment. To his contemporaries, he was also notorious for having published a few clandestine philosophic essays—whose atheistic trend caused him to be imprisoned for a few months in 1749. Finally, he was known as the author of two unsuccessful prose dramas and of influ-

Denis Diderot, a French author and philosopher, is famous primarily for having compiled and edited the Encyclopédie *(1745–72), a reference work promoting rationalist thought to which most of the thinkers of the French Enlightenment contributed. Diderot's other writings include novels, plays, essays of criticism, and philosophical works.*

ential works of dramatic criticism.

Today his reputation rests almost entirely on works that, for various reasons, he refrained from publishing during his lifetime. Few fit within the traditional literary genres. *The Nun* and *Jacques the Fatalist and His Master*, both published in 1796, are novels now viewed as brilliant experiments with fictional devices far ahead of their time. The same is true of *Rameau's Nephew*, a satiric dialogue commonly held to be his masterpiece, which was first published in 1805 in a German translation by Goethe. Beginning in 1759, he wrote several *Salons* (on the occasion of the semiannual exhibits of works by members of the Royal Academy of Fine Arts), which are now considered to be forerunners of modern art criticism.

Nicknamed by his friends "Le Philosophe," Diderot based much of his ongoing philosophic reflection on contemporary scientific developments, especially in the biological sciences, moving steadily closer to a radically materialistic view of the universe that he expressed in literary form—especially in *D'Alembert's Dream*, a group of three dialogues composed in 1769 and first published in 1830. Finally, the thousand or so letters preserved from his vast correspondence are nowadays among his best-appreciated writings.

A prolific writer on the most diverse topics, as facile in Greek and Latin as in Italian and English, endowed with an ebullient and gregarious personality, influential among literary, artistic, philosophical, and scientific circles—Diderot was one of the last exemplars of the ideal of the universality of knowledge. He was one of the most representative figures of his age, and one of the most modern.

Photo Jill Krementz © 1972

Joan Didion, an American novelist and essayist, writes tersely but elegantly about modern society. Her taut style conveys the emotionally arid climates surrounding her characters in Play It As It Lays *(1970) and* A Book of Common Prayer *(1977).* Salvador *(1983) is an account of her own visit to troubled El Salvador.*

Didion, Joan [did'-ee-uhn] Joan Didion, b. Dec. 5, 1934, is an American novelist, screenwriter, and essayist. Didion worked as a journalist and an editor in New York City before returning (1964) to her native California, the setting for her first novels. *Play It As It Lays* (1970) won high critical praise for its portrait of a woman whose life reflects the pointlessness and destructiveness of her society. Didion's style is almost devoid of exposition; her moral horror is communicated in concrete images. Other novels include *A Book of Common Prayer* (1977) and *Democracy* (1984). Nonfiction works include the book of essays *Slouching Towards Bethlehem* (1968), *Salvador* (1983), and *Miami* (1987).

Dido [dy'-doh] In Roman mythology Dido was the daughter of a king of Tyre. She fled to the African coast with large provisions and many followers after her brother Pygmalion murdered her husband. There she founded Byrsa, a fort that developed into the city of Carthage. The *Aeneid* by Vergil describes the arrival of Aeneas and the Trojan refugees, seeking hospitality at Queen Dido's court. Dido fell in love with Aeneas, and when he left Carthage for Italy, she killed herself.

Didrikson, Babe see Zaharias, Babe Didrikson

Diebenkorn, Richard [dee'-ben-korn] Richard Diebenkorn, b. Portland, Oreg., Apr. 22, 1922, is an artist whose paintings have alternated between figurative compositions and abstracted landscapes, both usually exuding a calm, pensive atmosphere. He is considered an important member of the California group of expressionist realists. In the mid-1950s Diebenkorn abandoned abstract expressionism to paint still lifes and interiors. In 1967 he began the *Ocean Park* series, harmonious geometrical abstractions that have only vestigial reminders of perspective and landscape.

Diefenbaker, John G. [dee'-fen-bay-kur] John George Diefenbaker, b. Grey County, Ontario, Sept. 18, 1895, d. Aug. 16, 1979, was a Canadian political leader. A lawyer in Saskatchewan, he ran several times for the House of Commons as a Conservative before being elected in 1940. He was a candidate for the leadership of the Conservative party in 1942 and 1948, and he finally became leader in 1956. The next year he succeeded Louis St. Laurent as prime minister. A passionate believer in Canada, Diefenbaker generated support that won his par-

John Diefenbaker, prime minister of Canada from 1957 to 1963, secured the largest majority in Canadian history for his Progressive Conservative government in 1958. Recession contributed to the loss of that majority in 1962, but Diefenbaker led a minority government until his defeat in 1963.

ty an overwhelming victory in the parliamentary election of 1958. His great majority was dissipated by indecision, however, and he was defeated in 1963.

dieffenbachia [dee-fen-bak'-ee-uh] The genus *Dieffenbachia* of the arum family, Araceae, comprises about 30 species of tropical American shrublike evergreen plants with fleshy stems. Species are commonly used as houseplants, particularly *D. amoena*, which has dark green leaves with irregular creamy-white zones radiating from the midrib. The bitter sap of the mother-in-law's tongue, *D. sequine*, is reported to cause the tongue and throat to swell; hence the common name "dumb cane."

Dieffenbachia amoena *is a common, decorative houseplant with long (up to 50-cm/20-in), attractive leaves.*

dielectric [dy-uh-lek'-trik] A dielectric is an electrical insulator that may be polarized by the action of an applied electric field. Dielectric materials include all materials that are not conductors, which is to say all materials except condensed metals.

Under the influence of electric fields, electrons move freely through conductors, whereas in dielectrics, or insulators, the fields displace electrons only slightly from their normal positions. Within each molecule of a dielectric, therefore, electric fields cause a separation of negative charges (electrons) from positive charges (protons in the atomic nuclei). Each molecule thus becomes an electric dipole, and the material is said to be polarized. Dielectrics such as water possess permanent dipole moments, and the applied electric field tends to align these dipoles along its own direction. This is called the orientation effect.

The induced dipoles are aligned so as to produce an overall dipole moment—the product of one of the charges and the distance separating the charges—and this moment reduces the strength of the applied electric field. (The reason for the reduction is that the dipole moment has polarity opposite to that of the field.) The factor by which the induced dipoles reduce the electric field is called the dielectric constant. Dielectric materials are widely used in the manufacture of electric circuit elements called CAPACITORS, which store electric charge.

Diels, Otto Paul Hermann [deels] The German chemist Otto Paul Herman Diels, b. Jan. 23, 1876, d. Mar. 7, 1954, was awarded the Nobel Prize for chemistry in 1950 jointly with Kurt Alder for his contribution to the discovery of the diene synthesis reaction. The reaction involves joining a diene (a compound with two conjugated double bonds) with another substance to form a compound with a ring of atoms. The reaction has a wide applicability in the synthesis of a variety of substances, such as drugs, medicine, plastics, and synthetic rubber. Diels's preparation of a hydrocarbon from cholesterol in the 1920s was an important contribution to an understanding of the structure of cholesterol, which was then determined by Adolf Windaus in 1927.

Diem, Ngo Dinh see NGO DIHN DIEM

Dien Bien Phu, Battle of see VIETNAM WAR

diene [dy'-een] Dienes, also called alkadienes, are a class of organic compounds that have two sets of carbon-carbon double bonds. When the double bonds are separated by one or more CH_2 groups, the bonds are said to be isolated, and the properties of their compounds are similar to those of simple ALKENES. Different and interesting behavior is shown, however, by dienes possessing cumulated double bonds such as those in allene, $CH_2{=}C{=}CH_2$, and conjugated double bonds such as those in 1,3-butadiene, $CH_2{=}CH{-}CH{=}CH_2$ (see CONJUGATION, chemistry).

The ability of 1,3-dienes to form polymers, especially forms of rubber, makes them valuable.

See also: POLYMERIZATION; RUBBER.

Dieppe [dyep] Dieppe is a seaport on the northern coast of France near the mouth of the Arques River. Its population is 35,957 (1982). It is a major fishing and commercial port on the English Channel. Industries include shipbuilding, oil refining, and textiles. Dieppe is also a popular beach resort, bordered by chalk cliffs. Dieppe has been known since medieval times for its fine ivory work, and a collection of this work can be seen in a 15th-century fortress museum.

Important because of its strategic location on the channel, Dieppe was a key French naval base in the 17th century. The town was devastated by plague (1668, 1670), 17th-century religious persecution (Dieppe was a HUGUENOT center), and wars. It suffered almost total destruction by Dutch and English forces in 1694 and by German occupation during the Franco-Prussian War (1870–71) and World War II (1940–44).

Dies, Martin [deez] Martin Dies, Jr., b. Colorado, Tex., Nov. 5, 1901, d. Nov. 14, 1972, was a Texas congressman who became nationally known as the first chairman (1938–45) of the House Committee on UN-

AMERICAN ACTIVITIES. He served in the House of Representatives from 1931 to 1945 and from 1953 to 1959. His critics charged him with using his committee chairmanship to carry on a vendetta against the New Deal of President Franklin D. Roosevelt, whose administration Dies claimed had been infiltrated by Communists and their dupes.

dies and die making see TOOL AND DIE MAKING

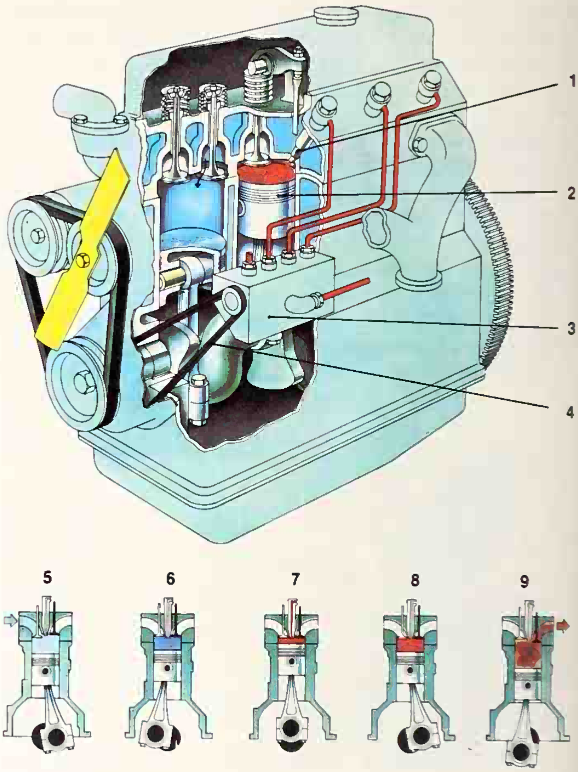
Dies irae [dee'-ays ee'-ray] The PLAINSONG sequence *Dies irae* (Latin, "day of wrath"), its poem probably by Thomas of Celano (d. *c.*1256), was made an obligatory part of the mass for the dead in the 16th century by the Council of Trent, although it is now optional. Even before the council met, however, composers had used it in their requiem masses. Later, composers of concert music often adopted the opening notes or the entire melody to represent death, damnation, and the supernatural.

Diesel, Rudolf see DIESEL ENGINE

diesel engine A diesel engine is a type of INTERNAL-COMBUSTION ENGINE that is similar to the gasoline engine, but requires no electrical IGNITION SYSTEM or CARBURETOR. It was invented by Rudolf Diesel, a German engineer, who obtained a patent for the design in 1892. Diesels employ high compression ratios to elevate the compressed air temperature sufficiently to ignite a low-grade fuel that is injected into the cylinder. Components of diesels are usually heavier than those of gasoline engines because of the additional structural strength needed to obtain the higher compression ratio and power output.

Diesel engines employ a system of fuel injection to spray the fuel into the cylinder after the air has been compressed by the piston. This mixture burns; the expanding gases push the piston down and thus supply power. The timing of this fuel injection is just as critical as is the spark that ignites the fuel in the gasoline engine. Therefore, the injection mechanisms are mechanically linked to the crankshaft. Since each cylinder takes in and compresses a fixed amount of air, the power of the engine is varied by the amount of fuel injected. The timing, as well as the duration and pressure of fuel injection, is designed so that the maximum useful energy is obtained from the fuel for a particular range of speed, power, acceleration, or other working conditions.

Diesel engines, like other internal-combustion engines, require an exhaust system, a cooling system, and a starting system. Because of the unusually high compression ratios, diesel engines need a powerful starting system. Some diesel engines use an electric motor or an auxiliary gasoline engine, whereas others use compressed air or spark ignition to start the engine. Diesel engines have always been popular power plants for large vehicles such as buses, trucks, locomotives, and ships. Small diesels have been used in automobiles, although the noise, soot, and pollutants they produce have discouraged that use in the United States.



The major operating parts of a four-stroke diesel engine are a fuel injector (1); *a compression piston* (2); *and a fuel pump* (3), *which is powered by the turning-crankshaft via a chain drive* (4). *These parts are instrumental in the four stages of the combustion cycle: intake, compression, combustion, and exhaust. The cycle begins as air is drawn into a cylinder through an inlet valve* (5). *Both valves are then closed, the piston rises, and the air is highly compressed* (6). *Just before maximum compression, fuel is injected into the hot air, and it spontaneously ignites* (7). *The fuel burns, driving the piston down and turning the crankshaft* (8). *The exhaust valve opens, and the combustion products are expelled* (9). *The cycle is then repeated.*

Today, continuing efforts are being made to apply diesel power to additional stationary uses, such as in central generating stations, industrial power plants, oil pipelines, and irrigation pumps. The diesel has been successful because of its operating advantages, such as low maintenance costs, greater efficiency, high power output, and fuel economy under all loads.

diet, human Because the human diet is typically diverse, human beings are classified as omnivores rather than as herbivores (plant eaters) or carnivores (meat eaters). Certain groups of people do derive most of their food from animal sources—for example, the traditional Inuits of the Arctic region and the Masai of Africa—while other people practice VEGETARIANISM. By far the majority of humankind, however, eats a wide range of foods of both animal and vegetable origin.

Traditional Food Habits. Throughout history, different societies have exhibited great variations in diet. So long as the food supply was sufficient, however, the traditional diets of most cultures have provided all the essential nutrients (see NUTRITION, HUMAN). These nutrients may be divided into macronutrients (CARBOHYDRATES, FATS, and PROTEINS) and micronutrients (VITAMINS AND MINERALS). In general, humans obtain most of their food energy (see CALORIE) from carbohydrates (perhaps 65% worldwide); lesser amounts come from fat (about 20%) and protein (about 15%), derived mainly from meat and fish.

In terms of food groups, cereal GRAINS provide about 70% of the food energy consumed by humans. The most widely used cereals are rice, wheat, and corn; these are followed by millets, sorghum, oats, barley, and the teff grass of Africa. Other important energy sources are the root crops, such as manioc (cassava); potatoes; and other starchy foods such as plantain and sago. Almost every human society regards one of these foods as its principal staple.

Legumes such as lentils, peas, beans, and peanuts also form an important part of the diet of almost all cultural groups, although they seldom are the main staple. These legumes, or pulses, are nutritionally important because most of them contain considerably more protein than do most cereal or root crops. The ratio of amino acids found in legume protein also often complements the ratio present in the staple food.

Fruits (see FRUITS AND FRUIT CULTIVATION) and VEGETABLES are of lesser importance in human diets in terms of their macronutrient content, but they supply essential vitamins and minerals as well as fiber. In the diets of many countries, certain vitamins such as vitamin C and carotene (the precursor of vitamin A) are obtained mainly from this food group.

Humans also consume a variety of fats and oils of both animal and vegetable origin and eat a wide range of condiments, flavorings, and spices. Outside of salt, which supplies the trace elements sodium and chlorine, most of the latter are of little nutritive importance, but they often help to increase the appetite and to assist digestion.

Changing Food Habits and Related Problems. Traditional food habits in themselves have rarely been the cause of malnutrition and NUTRITIONAL-DEFICIENCY DISEASES. The usual cause of such problems has been a simple lack of food, whether because of environmental conditions or of poverty. The poor in any society may be forced to consume less food or a more limited variety of foods than they require. If the staple is protein-low manioc or plantain, for example, the poor who cannot afford supplementary legumes or animal products may suffer from kwashiorkor; if the staple is maize, pellagra may become prevalent if other foods are not consumed along with it.

Whereas advances in agriculture and food-processing techniques have afforded the potential of increased food supply and a nutritionally enriched diet, modernization and westernization of traditional food habits have also had their deleterious effects. For example, the substitution of bottle-feeding for breast-feeding among poor families in developing countries has been responsible for a great deal of malnutrition and diarrheal disease.

Changing food habits have had harmful effects in the affluent developed nations as well. The proportion of energy obtained from carbohydrates has tended to become lower (often ranging from 35% to 50%), while that obtained from fats and protein—particularly animal protein—has tended to rise. This represents an inefficient use of agricultural resources; in addition, the increased intake of saturated fat and cholesterol has been related to an increased prevalence of cardiovascular disease in developed nations.

dietary laws Dietary laws are regulations that prescribe the kinds of food or drink that may or may not be consumed. Most of the world's religious traditions have regulations of this sort and make dietary observances part of an ideal life-style as envisioned by one's faith. The expression of dietary rules varies considerably, however.

Dietary regulations sanctioned by religion have occasionally had other than purely religious meanings. Some, under the prevailing conditions of climate and life, had hygienic value at least at their time of origin. Others were established to conserve valuable food resources and assure adequate protein supplies for the leaders and warriors upon whom the security of the society depended. But religious dietary laws are derived, in the eyes of believers, primarily from religious authority and express religious realities. They occur within the context of the general symbolic meaning of food as establishing exchange and community, which can also be seen in festivals, sacrifices, and sacraments like the EUCHARIST. The significance of food as a symbol for the spiritual life is conversely apparent in FASTING and ASCETICISM; abstinence from food for explicitly religious reasons is often viewed as a mark of holiness or as an aid to spiritual growth.

Primitive Religion. Among primitive peoples dietary rules are primarily TABOOS that symbolically uphold the mythical, social, and economic orders of the tribe. For example, the flesh of a people's TOTEM animal may be forbidden or may only be eaten at festivals to establish communion with it. Certain foods may be reserved only for the chieftain's house, indicating the sacred character of the ruler. Particular foods may be avoided during a hunt or a war as part of the magic that brings fortune to those ventures.

Hinduism. Hindu dietary laws work primarily to express a person's place in the hierarchy of caste. The highest Brahmin priests take only vegetarian food prepared with clarified butter (*ghee*) and abstain from alcohol and strong foods such as onions and garlic. The further one goes down the caste scale, the looser the proscriptions. Pure VEGETARIANISM gives way first to eggs, then to lighter meats, and finally to beef. In India the one who prepares food and the one from whom one receives it are also crucial to one's place in the social order, which, in turn, was traditionally perceived as sacred.

Buddhism. Buddhist belief inculcates nonkilling of sentient life and abstinence from alcohol. The former precept is generally taken as encouraging vegetarianism, but it, like the avoidance of spirituous liquors, is scrupulously observed only by some monks and exceptionally devout laity.

Judaism. The traditional Jewish dietary laws are not observed by all Jews today, but they are very important to understanding Jewish history and culture. These laws contain no restrictions governing plant food. Animals eaten must have a split hoof and chew their cud; this includes sheep and cattle but excludes swine. Of sea creatures, only those with fins and scales may be consumed; of aerial creatures, carnivorous birds and insects are excluded. Meat must be slaughtered and prepared in special ways to make it kosher, or edible by those keeping the dietary laws. Moreover, meat and dairy products may not be eaten together.

Christianity. The most important dietary practice in Christianity has been abstinence from meat on Fridays, in commemoration of the crucifixion of Jesus Christ. This practice has been prevalent traditionally among Roman Catholics, Eastern Orthodox Christians, and Anglicans. There have also been similar practices involving fasting and abstinence during the season of LENT. Some Protestant groups discourage or forbid their members to use alcohol. A few, such as the Seventh-Day Adventists, have encouraged vegetarianism.

Islam. The dietary laws of Islam are based in part on those of Judaism. They forbid eating animals found dead, blood, pork, and food sacrificed or offered to idols. Islamic practice departs from Jewish practice in that alcohol is forbidden.

diethylstilbestrol see DES

dieting The term *dieting* most commonly refers to the revision of food intake in order to lose weight, although diets are also observed for a wide range of medical reasons or to accord with DIETARY LAWS or ethical positions such as VEGETARIANISM. In the United States and other developed nations where OBESITY is a common metabolic problem, the promotion of weight-loss programs has become a large enterprise. This interest in dieting is caused in part by a cultural emphasis on the desirability of slimness, but obesity also puts people at risk for cardiovascular problems, diabetes, and other disorders.

People often find diets hard to maintain, in part because they may have unrealistic expectations about how quickly they can lose weight. They may blame the diet itself and try another one. Many fad diets, however, are unhealthy and even dangerous. The only proper weight-loss diets are those which observe good nutritional practices (see NUTRITION, HUMAN).

General Guidelines. In nutritional science, food energy is spoken of in terms of a heat unit, the CALORIE (actually the large calorie, or kilocalorie). The only sources of calories are CARBOHYDRATES, PROTEINS, FATS, and ALCOHOL. If the number of calories taken in greatly exceeds the number used, the excess is stored as fat and obesity results. With proper dieting and exercise, however, the fat stores in the body will supply some of the dieter's energy needs while maintaining good health. For most people, the recommended rate of weight loss is about 0.7 to 0.9 kg (1.5 to 2 lb) per week. This can be achieved on diets limited to 1,200–1,500 calories a day for women and 1,500–2,000 calories a day for men; calorie needs of children vary greatly, and their rates of weight loss should be prescribed by a physician.

The sensible approach to weight loss begins with a medical checkup to make certain that no special health problems exist, and to get a diet and exercise prescription from a physician. Diets acceptable to the medical establishment are those in which fewer calories are eaten and the amount of exercise is increased. Some diets place more emphasis on calorie reduction and others on increased exercise, but all of them emphasize the importance of good nutrition and maintaining a balance of proteins, carbohydrates, and fats.

Diet Problems. Many commercial diets emphasize one dietary element at the expense of others, thus presenting health problems. Low-carbohydrate diets restrict the amount of bread, sugar, and grains while maintaining normal amounts of protein and fats. Most of the initial rapid weight loss from such programs is from the body ridding itself of water and salt. Most people experience fatigue, hypotension (low blood pressure), and dizziness after a few days on such diets.

High-protein diets virtually eliminate carbohydrates and fats, forcing the body to burn stored fat and protein for energy. A condition called ketosis may result. High-protein diets can be used for only a short period of time and are dangerous for anyone with diabetes, kidney disorders, or other medical problems.

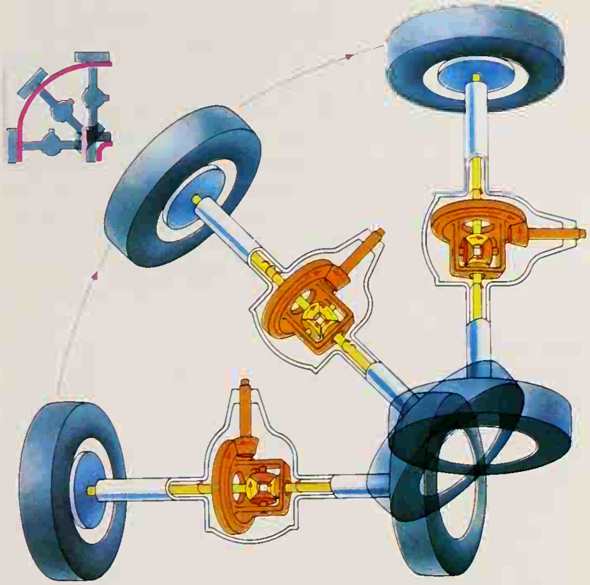
High-fat diets require complete elimination of carbohydrates for the first weeks, with very small amounts added during successive weeks. Such diets also cause ketosis and, because they are high in fats and CHOLESTEROL, are hazardous for persons with atherosclerosis and heart disease. The diets also cause diarrhea, vitamin loss, hypotension, and dehydration, and they irritate the kidneys.

Numerous diets emphasize one food, such as rice, grapefruit, ice cream, or yogurt. These are obviously not nutritionally balanced, require vitamin and mineral supplements, and should be used at most for only a very short period of time. Formula diets in liquid or powder form, which typically supply from 900 to 1,200 calories per day, claim to contain the recommended daily allowances of nutrients; serious health problems, however, have sometimes been reported with their use. Nonprescription drugs called anorexics are supposed to suppress the appetite but have little effect by themselves and must be used with a sensible diet plan; there are some indications that they, too, can be harmful. As for starvation dieting, this dangerous practice should be attempted—if at all—only under strict medical supervision. Such extreme practices may also indicate psychological disturbances such as ANOREXIA NERVOSA and BULIMIA.

Dietrich, Marlene [dee'-trik] Marlene Dietrich, b. Maria Magdalene von Losch in Berlin on Dec. 27, 1901,

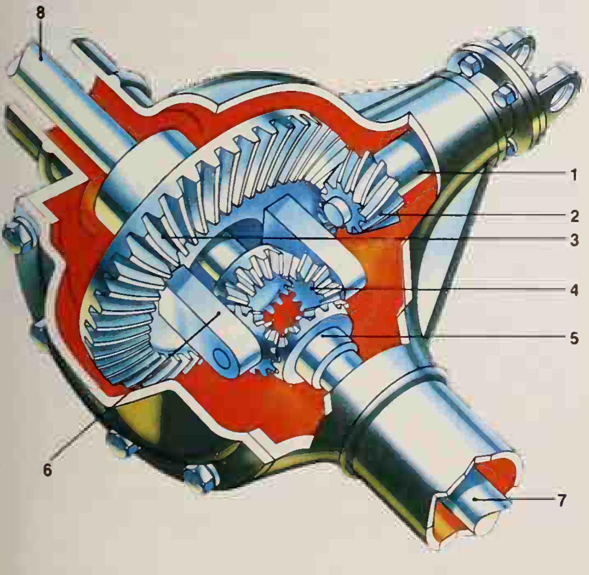
Marlene Dietrich appears as a dance hall singer in The Blue Angel *(1930), the film that established her as an international celebrity. Dietrich's performances, both on screen and in nightclubs, were imbued with a languid sexuality.*

was transformed by director Josef von Sternberg into an international sex goddess with her role in his film *The Blue Angel* (1930). Her unfathomably erotic image was further established by their continued collaboration in the 1930s in such films as *Shanghai Express* and *Blond Venus* (both 1932). She successfully changed from vamp to comedienne with her role as saloon singer in *Destry Rides Again* (1939). Later noteworthy films include *A Foreign Affair* (1948), *Rancho Notorious* (1952), and *Witness for the Prosecution* (1957). During the 1950s, when her film career waned, Dietrich took to the road with a cabaret act, which, enhanced by her living-legend persona, was highly successful.



When a vehicle negotiates a turn, the inner wheel must rotate more slowly than the outer wheel because it has a shorter distance to travel. The gearing within a differential accomplishes this by allowing the two axlehalf-shafts to rotate at different speeds.

Engine torque turns the drive shaft (1) *and pinion gear* (2), *which rotates the ring gear* (3). *Pinion gears* (4) *and side gears* (5) *inside the differential housing* (6) *allow the axle shafts* (7, 8) *to turn the outer and inner wheels at different speeds when going around a curve.*



differential Differential gears in an automobile's drivetrain allow the driving wheels to transmit torque, or twisting force, at different turning rates. Thus one wheel can follow the longer arc around the outside of a turn while the other wheel tracks the shorter inside arc without skidding on the road surface.

In a front-engine, rear-drive car, engine torque flows through the transmission and drive shaft to turn the ring-and-pinion gears inside the rear-axle assembly, powering the rear driving wheels. In a front-engine, front-drive car, the differential and final drive gears are in the same housing with the transmission, mounted directly on the engine. In both designs, the drive gears work through differential gears to turn the axle shafts and the driving wheels.

The drive shaft ends in a pinion gear inside the differential. When the drive shaft turns, the pinion drives a ring gear that is part of the differential housing, so that both housing and ring gear rotate together. Inside the housing are two pinion gears and two side gears; each side gear is connected, via an axle, to a drive wheel. When the car drives straight ahead and the axle shafts turn at the same speed, the differential housing rotates, but no differential action occurs. When the car negotiates a turn, however, the differential must compensate for the difference in distance traveled by the drive wheels. The pinions roll around the side gears, allowing the inside wheel to turn more slowly and the outside wheel to turn faster.

Free-turning gears divide torque equally between the driven wheels. If one drive wheel is on dry pavement and the other on ice, the gears roll around inside the housing to spin the slipping wheel at twice the ring gear's speed. Each drive wheel gets the same slight amount of torque required to spin the slipping wheel; the car does not move at all. Some cars have locking, or limited-slip, differentials to reduce wheel spin by transferring some torque to the wheel with better traction.

Many vehicles now have full- or part-time four-wheel-drive (4WD). Part-time 4WD cars are driven in 2WD on paved roads. Most modern 4WD cars add an extra differential between the front and rear wheels so the front and rear driving wheels can turn at minutely differing rates. In some vehicles with full-time 4WD, limited-slip differentials couple the front and rear final drive gears.

differential analyzer The differential analyzer is a type of analog computer. It was first conceived in 1876 by William Thompson (Lord Kelvin) to solve differential equations. The first successful type was a mechanical apparatus built by Vannevar Bush and colleagues at the Massachusetts Institute of Technology in 1930.

By 1945 about a dozen Kelvin-Bush differential analyzers were in worldwide use on a wide range of applications. Later models incorporated electrical coupling and control from digital punched tape. Further advances led to the modern hybrid computer.

differential calculus Differential calculus is a branch of calculus that concerns itself with functions of real variables by studying their derivatives. The concept of the derivative is an extension of that of the average change of a function over small intervals. It is the principal tool of differential calculus. With it, mathematicians can investigate geometrical properties of curves and surfaces; find the rates of change of quantities; and predict the maxima and minima that these quantities will assume over some period of time. A related branch of mathematics is analytic geometry.

The concept of a function was first clearly defined—by the French mathematician Jean Le Rond d'Alembert, in the mid-18th century—as a rule that assigns to each value of some independent variable one corresponding value of a dependent variable.

Development. The study of rates of change began in the ancient world. Ancient astronomers were interested not only in the rate of change in a planet's position but also in the rate of change of that rate. It was only in the 17th century, however, that methods practically identical with those of differential calculus were discovered. For example, one major precursor, the French mathematician Pierre de Fermat, solved mathematical problems using certain techniques of differential calculus.

The honor of discovering calculus, however, is shared by Isaac Newton and Gottfried Wilhelm von Leibniz, both of whom developed it independently. Leibniz was the first to publish an account of calculus, in 1684, and he gave the subject its name and much of its symbolism; but Newton actually discovered it first, probably in 1665.

Basic Concepts. The basic idea of differential calculus is seen in the solution to a problem such as finding the speed of an object falling to earth, at the end of 5 seconds of fall. Galileo Galilei discovered, early in the 17th century, that a body falling to Earth will have fallen (neglecting air resistance) a distance of $s = \frac{1}{2}gt^2$ at the end of t seconds, where g is the acceleration (9.8 m/sec/sec) due to the force of gravity. Thus, the value of s is the function of t given by the formula $s(t) = \frac{1}{2}gt^2$. Hence, $s(1) \times \frac{1}{2}(9.8)(1)^2 = 4.9$ m, and $s(5) = 122.5$ m.

The question that differential calculus would address is that of how *fast* the body is falling at the end of 5 seconds. That is, what is the instantaneous rate of change of the distance function $s(t)$ when $t = 5$? The idea is that the average speed over small intervals of time that start or end at 5 seconds will be close to the instantaneous speed at the time 5 seconds. The small intervals of time, called increments of time, are symbolized $\Delta t = t - 5$, where t is some time close to 5 seconds. Each such time determines an increment of distance $\Delta s = s(t) - s(5)$, which, if t is greater than 5, is the distance the object falls in the time from 5 to t. If t is less than 5, then $s(t)$ is the negative of the distance the object falls in the time from t to 5. In either case, average velocity in the interval Δt is the distance traveled divided by the time elapsed, or $(\Delta s)/(\Delta t)$. For example, if $t = 4$, then $\Delta t = 4 - 5 = -1$, and $\Delta s = s(4) - s(5) = 78.4 - 122.5 = -44.1$. Thus, the average velocity in the time interval from 4 to 5 seconds is $\Delta s/\Delta t = -44.1/(-1) = 44.1$ m/sec.

The quotient $\Delta s/\Delta t$ is called the difference quotient of s, and it is of great importance in differential calculus. The operation of letting t take values ever nearer to a given value t_0 is called taking the limit of the difference quotient as t goes to t_0; it is described as the limit, as t approaches t_0, of the expression $[s(t) - s(t_0)]/(t - t_0)$.

This expression is called the derivative of the function $s(t)$ with respect to t, and it is the most important idea in differential calculus.

Further Developments. In the 19th century the French mathematician A. L. Cauchy used the idea of limit of a difference quotient to give a rigorous definition of derivative. By this time, partial derivatives of functions of several variables were also studied, and differential calculus was thereby applied to surfaces and not just curves.

differential equations Differential equations are equations that relate a quantity to its rate of change. They often arise in the study of problems in engineering, natural science, and social science, where they are suggested by the results of observations or experiments, or they are posed as hypotheses for testing. Such equations are important because many phenomena can be described by a quantity whose rate of change is intrinsically related to the magnitude of the quantity. Since the discovery of calculus in 1664–66, differential equations have been applied to problems in such fields as mechanics, electromagnetic theory, relativity, and quantum mechanics. Some biological and economic processes can also be described by models using differential equations.

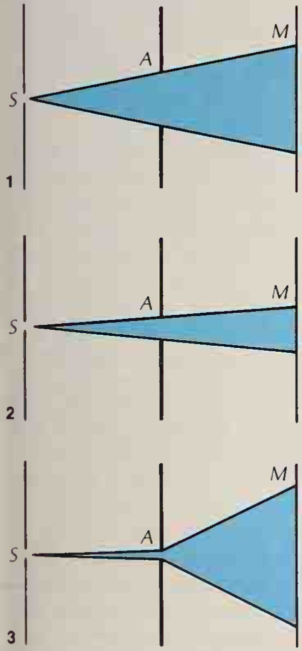
differential geometry Differential geometry is the application of the concepts and methods of differential calculus to the subject of geometry. Such local properties of curves and spaces as curvature and tangency are investigated, using derivatives. Differential geometry has significant applications in such areas as relativity theory and geodesics. Gaspard Monge is considered the inventor of differential geometry.

Difflugia [dih-floo'-jee-uh] *Difflugia* is a genus of unicellular, amoebalike organisms of the class Sarcodina or Rhizopoda, kingdom Protista. *D. corona* constructs a shell by cementing sand grains together with a cellular secretion. The shell possesses an opening, or "mouth," with a border of toothlike structures. Variations in these structures are determined by cytoplasmic elements and do not display the conventional Mendelian pattern of heredity dictated by genes. The organisms have been studied extensively for this reason.

diffraction Diffraction is a bending, or change in the direction of, a light wave or other wave, when the wave passes near an object's edge or through a narrow aperture. All wave phenomena are subject to diffraction—including electron beams, which can exhibit wavelike behavior. The effect is easily observed in water waves, which can bend around obstructions in water. Diffraction is also easily seen when a light is observed through a fog. The tiny water particles diffract the light and give a halo effect to the light source.

The effects of light diffraction are significant only when small-scale phenomena are considered. They are especially important there, however, because they affect the design and performance of optical instruments such as microscopes, in which very narrow beams of light are involved. Two major cases exist in which light diffraction is observed. In the first, light that passes through a small aperture does not form a sharp image of the aperture on a screen. Instead the image is diffuse, and a series of bright and dark rings, or fringes, outline the image. The rings fall within the region where the image otherwise would be obscured—that is, the geometric shadow of the aperture. This effect is directly observed only if the size of the aperture is no wider than a few wavelengths of light, or less than a millimeter. The second case occurs when light is bent around the edge of a smooth object. In the region of the object's geometric shadow, a series of fine bright and dark fringes is observed instead of a sharp shadow edge.

See also: Airy disk; interference; optics; waves and wave motion.



Light from a source (S) *generally passes in a straight line through a hole* (A) *to form a bright spot on a screen* (M,1). *As the hole decreases in size* (2), *the spot shrinks correspondingly. When the diameter* (3) *of the hole is less than 0.3 mm (0.01 in), however, the light spreads out to form a large, central spot surrounded by faint rings. This phenomenon was termed diffraction by its Italian discoverer, Francesco Grimaldi, about 1650.*

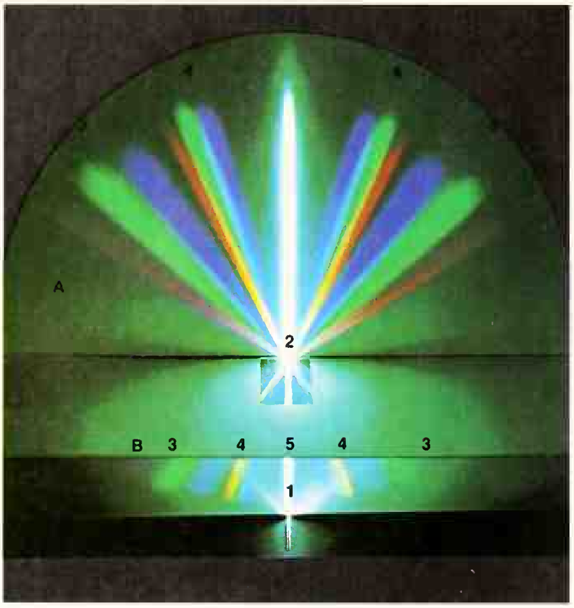
diffraction grating The diffraction grating is a precise optical component of spectroscopes and various measuring machines. Used like a prism, which separates light into its constituent wavelengths, it may consist of a surface ruled with thousands of accurately spaced, parallel slits, each slit being only several light wavelengths wide. These are termed transmission gratings. Some gratings consist of a series of similarly spaced, parallel-reflecting surfaces (reflection gratings). Gratings used in the visible and ultraviolet regions have at least 6,000 to 18,000 lines per centimeter; in the infrared region, they have from 700 to 3,000 lines per centimeter. Gratings with as many as 50,000 lines per centimeter have been developed for use in high-resolution instruments.

The separation of light into its constituent wavelengths with a grating is the result of constructive and destructive wave interference after the light is bent by the grating rulings (see diffraction). A prism, on the other hand, separates light on the basis of differing indices of refraction. When a grating is placed at a proper angle to an incident beam of light, the light beam will be dispersed; that is, it will be divided into its constituent wavelengths. The result is a spectrum of the entering light.

The diffraction grating was invented in 1821 by Joseph von Fraunhofer of Munich as a major improvement over the optical prism. The dispersive action of a grating produces multiple spectra, whereas a prism produces only a single spectrum. In 1882 the American physicist Henry A. Rowland improved the device by ruling reflection gratings on concave metal surfaces, thus eliminating the need for a collimator and focusing lens in a spectroscope.

In 1949 the Echelle grating was introduced to provide high resolution with fewer lines, but its usefulness is limited to a narrow band of wavelengths.

In measuring machines, diffraction gratings are used



Diffraction gratings can produce spectra either by light reflection (A) *or by transmission* (B). *A beam of white light passing through a slit* (1), *and diffracted by a grating* (2), *produces second-order* (3), *first-order* (4), *and undeviated zero-order* (5) *diffraction patterns.*

in pairs, because the relative movement of two gratings creates optical patterns (moire patterns) or fringes. These patterns are detected by photocells, and their outputs are fed into a computer to provide a digital readout of movement, with a resolution of about 0.00127 cm (0.0005 in).

diffusion Diffusion is the process by which molecules or similar particles move spontaneously from a region where they are present at a relatively high concentration into regions of lower concentration. The process does not depend on stirring or other mechanical stress. At ordinary temperatures molecules are in constant, random motion; hence, the number of molecules moving out of a given volume of high concentration will be greater than that moving into it, and this process will continue until the concentration is uniform throughout. A familiar example of diffusion is the release of an odorous substance in some part of a room. Diffusion may also occur through a solid barrier if it is crossed by channels or pores large enough to let the molecules pass (see OSMOSIS).

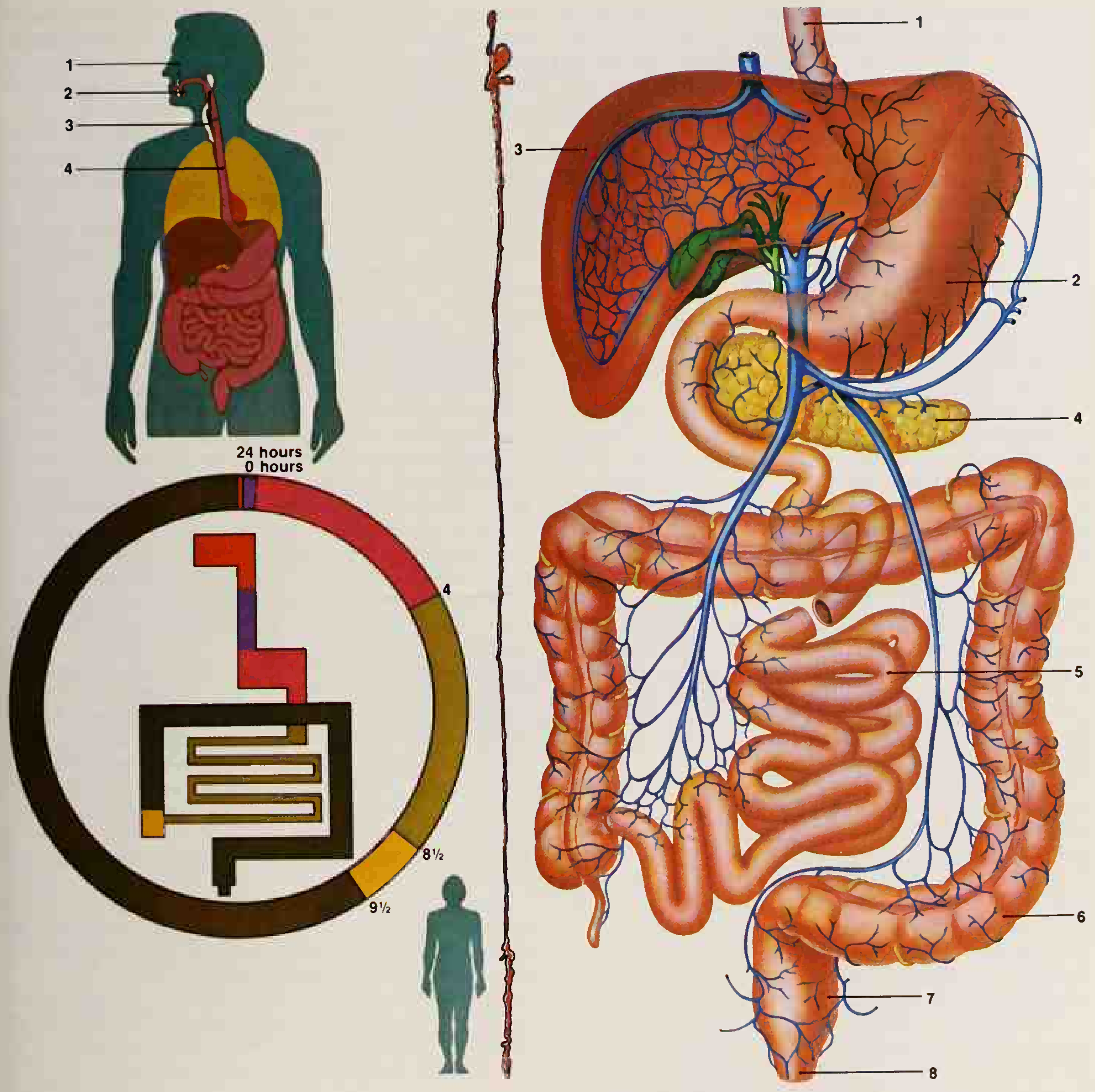
In gases, diffusion takes place readily; the rate of diffusion is proportional to the square root of the temperature and inversely proportional to the square root of the molecular weight. In liquids, diffusion depends on the viscosity of the medium as well as the size and shape of the molecules. The latter may be estimated, on the basis of certain assumptions, from quantitative measurements of the diffusion velocity. Diffusion is important in biology, because the movement of substances into and out of cells usually involves diffusion through the cell membrane. Diffusion can also occur in solids, though much more slowly than in liquids.

diffusion, cultural Cultural diffusion is the process by which CULTURE traits or complexes of one society or ethnic group are borrowed by another, resulting in their spread from a center of origin to other, distant geographical areas. It is, along with independent discovery and invention, an important process of culture change and is regarded by some anthropologists as the predominant force behind culture change. Borrowed elements diffused from one group to another usually undergo change or adaptation over time by the people in the receiving culture. Many examples of cultural diffusion result from what is called *stimulus diffusion*, whereby the idea or principle behind a particular culture trait is diffused even though the culture trait itself is not adopted. Stimulus diffusion must have played an important role in the spread of agriculture and animal domestication throughout the prehistoric world.

digestion, human Digestion in humans, as in other animals (see DIGESTIVE SYSTEM), is the process in which nutrients such as PROTEINS, FATS, and CARBOHYDRATES are taken in and broken down to a form that can be readily absorbed from the gut for circulation to and use by various cells. The body is thus provided with nutrients required for METABOLISM—the sum total of physical and chemical processes by which body materials are produced and maintained. Nutrients supply the molecules from which energy, as calories, can be derived for cellular synthesis, cell and organ growth, and tissue replacement. In addition, nutrients provide the components that are needed in these processes but that the host is unable to synthesize, such as VITAMINS AND MINERALS, electrolytes, and certain essential amino acids and FATTY ACIDS. Failure to provide any of these leads to deficiency states.

Digestive Tract. Food enters the digestive tract via the mouth, where it undergoes physical change through chewing. ENZYMES, such as ptyalin, that initiate sugar digestion are introduced in salivary secretions, which also provide lubrication to facilitate chewing and swallowing. The food passes through the ESOPHAGUS and is retained in the STOMACH. There it is liquefied by a mixture of hydrochloric acid and pepsin, which is secreted by the stomach wall. Simultaneously, a substance called intrinsic factor, for vitamin B_{12} absorption, and various gastric enzymes such as pepsin that initiate protein digestion are secreted into the digestive cavity. Secreted mucus coats the cells that line the stomach. The stomach's contents are then metered out by PERISTALSIS, passing through the pyloric valve into the DUODENUM, the first portion of the small INTESTINE.

A common duct from the PANCREAS and the GALLBLADDER into the duodenum serves as a conduit to introduce bicarbonate (to neutralize hydrochloric acid), pancreatic enzymes (for degradation of proteins and carbohydrates), and bile salts (for fat absorption; see LIVER). Peristalsis



(Center) *The human digestive system, a long tract in relation to body length, takes in and absorbs food for the body. An individual chews food with teeth* (1) *and the tongue* (2). *Food moves from the mouth into the pharynx* (3), *down the esophagus* (4), *and into the stomach* (5). *Through peristalsis, the muscular action of the stomach, the food is churned. Digestive juices supplied by the liver* (6) *and the pancreas* (7) *emulsify the food and convert it into a semiliquid mass. The small intestine* (8) *absorbs digested food into the blood circulatory system as nutrients for the body. The large intestine* (9) *condenses unused food matter and expels it through the rectum* (10) *and anus* (11). (Bottom left) *About 24 hours is required for food to pass through the digestive tract, as illustrated by a time scale in which each color indicates the food's location in the system.*

moves the semiliquid food mass, or chyme, into the next portion of the small intestine, the jejunum, where the bulk of digested carbohydrate and protein, water, water-soluble vitamins, electrolytes, and minerals are absorbed. Remaining nutrients are propelled to the last third of the small intestine, the ileum. Here fat, fat-soluble vitamins, vitamin B_{12}, and bile salts are absorbed. Some fluid, indigestible residues, and cellular debris pass through the ileocecal valve into the colon, which is the major reservoir for intestinal bacteria. Here additional water is extracted, potassium is excreted to maintain electrical neutrality, and the chyme is thickened to form stool. This, in turn, is propelled by peristalsis into the rectum for evacuation. Normal stool weight is approximately 250 g (9 oz) daily, of which 10 to 20 percent is bacteria. Stool contains indigestible fiber (see NUTRITION, HUMAN), metabolic end products, water, fats, electrolytes, and small amounts of protein (see FECES).

Nutrient absorption essentially occurs in the small intestine. In the normal adult the small intestine is about 5 m (16.4 ft) long, with an enormous absorbing surface, the mucosal epithelium. The area of the mucosa is increased by small fingerlike projections called villi, which protrude into the intestine. Each absorbing cell of the mucosa is additionally endowed with microscopic brushlike projections, or microvilli, on the surface. These factors increase the absorbing surface 600-fold. The outside surface of the small bowel, the serosa, contains the musculature responsible for peristaltic activity.

Fat Digestion. In the Western world the adult consumption of dietary fat (LIPID) varies from 60 to 100 g (2 to 3.5 oz), primarily in the form of triglycerides—three long-chain fatty acids attached to a GLYCEROL backbone. In the small intestine, lipase from pancreatic secretions splits this molecule into two fatty acids and monoglyceride. Although none of these lipids is water soluble, they are brought into solution by bile salts that act as detergents. Dispersed fat molecules contact absorbing cells, and bile salts release the monoglyceride and fatty acids (or other lipid-soluble nutrients) into the cell membrane and eventually into the venous blood supply to the liver. In the gallbladder new and recycled bile salts are collected from the liver. During gallbladder contraction in response to a fatty meal, the bile salts are discharged into the small bowel.

Carbohydrate Digestion. Adults consume approximately 300 to 600 g (10 to 20 oz) of carbohydrate daily, consisting of STARCH, sucrose, lactose, and incidental amounts of other SUGARS. Starch is a polysaccharide comprising glucose molecules arranged in long chains with branches. Starch digestion is initiated by salivary amylase during chewing and is stopped by gastric acid in the stomach. Starch is further digested in the duodenum by pancreatic amylase to various branch-containing components of maltose and isomaltose.

These starch components are then hydrolyzed to glucose molecules by enzymes, called maltases, located in the microvilli of the intestine. At the same time, sucrose is hydrolyzed by sucrase to glucose and fructose, and lactose is hydrolyzed by lactase to glucose and galactose. The sugars are transported into the intestinal cells and then pass by diffusion into neighboring blood capillaries.

A deficiency of one or more of the disaccharidases—maltase, sucrase, and lactase, the latter being most common—may occur. If it does, sugars remain undigested in the gut cavity and accumulate water, which leads to distention. In the colon, bacteria utilize the sugars to produce acid and gas, resulting in DIARRHEA.

Protein Digestion. Average adult consumption of protein is about 50 to 75 g (1.7 to 2.6 oz) per day. Protein digestion is initiated in the stomach by acid and pepsin secretion. In the duodenum and upper jejunum the pancreatic enzyme trypsin breaks down most of the undigested proteins to their final products. Protein is hydrolyzed to smaller units containing short chains of amino acids, or to small peptides containing two to six amino acids.

For a short period in the newborn, absorption of ingested intact protein occurs by a process called pinocytosis, in which the absorbing cell of the gut engulfs large peptide fragments. In some infants who are given cow's milk, the milk protein absorbed acts as a foreign protein, resulting in a hypersensitivity reaction, or milk ALLERGY.

Fluid and Electrolyte Absorption. Approximately 5 to 10 l (1.3 to 2.6 gal) of water, derived from food and drink as well as salivary, gastric, pancreatic, biliary, and intestinal secretion, circulate through the digestive tract daily. All but 500 ml (15 fl oz) is absorbed in the small bowel. Of the remainder, slightly more than half is absorbed in the colon. Water transport in the small bowel occurs in response to osmotic gradients (see OSMOSIS). That is, as the concentration of nutrients increases intracellularly during active transport, the osmotic pressure increases, causing an influx of water into the cell. Some electrolytes dissolved in this water thus enter the absorbing cell by "solvent drag." The remaining electrolytes—bicarbonate, sodium, potassium, and chloride—are absorbed along the length of the small intestine by diffusion. In addition, some sodium enters the cell during active transport of sugars and amino acids.

Iron Absorption. In the United States adults ingest up to 20 mg of iron daily. Of this amount, about 0.5 to 1.0 mg is absorbed in healthy individuals. This may be increased up to fourfold in individuals who are iron deficient. Iron in food may exist primarily as inorganic (ferrous) iron and a smaller portion as ferric iron. Another source of dietary iron is HEMOGLOBIN iron, which is hydrolyzed to heme and globin and then further degraded to release free ferrous iron. Uptake of iron occurs almost entirely in the duodenum.

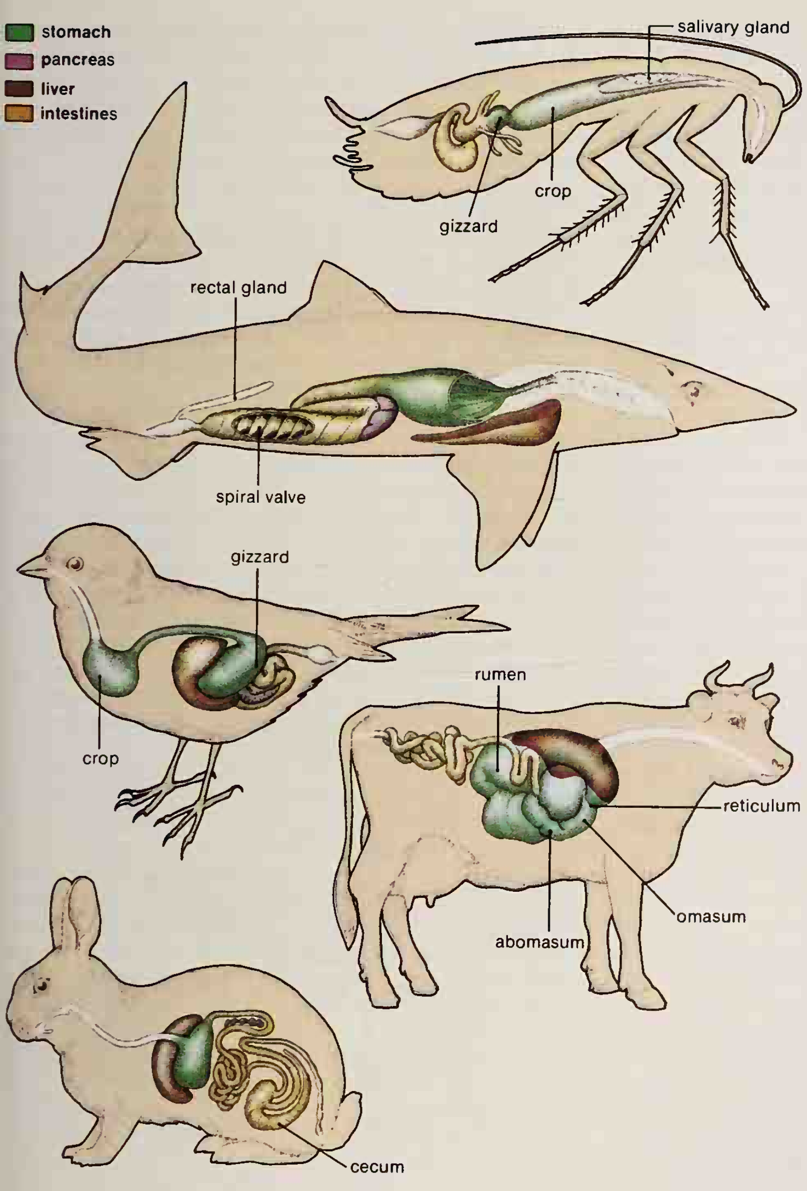
Calcium Absorption. Absorption of calcium occurs mainly in the duodenum. Vitamin D facilitates calcium absorption up to four times more than the absorption level in vitamin D deficiency states.

Vitamin Absorption. Fat-soluble vitamins are absorbed by the same mechanism used for the absorption of fat. At present, it is believed that most of the water-soluble vitamin absorption occurs by a passive process.

digestive system Digestive systems act on nutrients taken from the environment, breaking them down to simpler products, and then absorbing the products together with water and salts so they can be used in METABOLISM.

Any organism contains many different PROTEINS or CARBOHYDRATES, but foreign proteins or carbohydrates are rarely incorporated unchanged. They are usually first broken down to their constituents before being built up again as the proteins or carbohydrates belonging to the organism.

In such unicellular organisms as amoebas, digestion



Digestive systems break down complex nutrients into simple materials that can be readily utilized by an animal. The needs of a complex organism require a complex digestive system that has the same basic form in most species: a muscular tube that extends from the mouth, through which food is taken in, to the anus, through which wastes are eliminated. In addition, specialized organs and tissues carry out various steps in the process, such as secreting digestive enzymes into the tube. Although many of these organs—such as the stomach, pancreas, liver, and intestines—perform similar functions in different species, certain specialized, diet-related adaptations have developed. The cockroach, like many insects, has salivary glands near its mouth, which secrete digestive enzymes, including amylase, a starch-digesting enzyme. The esophagus is enlarged to form a storage organ called the crop, which discharges into the gizzard, a muscular organ that grinds food. The shark has a spiral valve in its intestine; this spiral-shaped fold of the interior wall provides a larger surface for greater efficiency. A special rectal gland excretes salt taken in from seawater. A bird's digestive system is specialized for the high metabolic rate needed for flight. The finch, like all birds, has a crop in which large amounts of food can be stored. Although the finch has no teeth, it breaks food down with the gizzard, a muscular part of the stomach that contains ingested stones for grinding. A cow feeds on plant matter, which contains cellulose; its four-chambered stomach is specially adapted to process its food. Bacteria and protozoans in the first two chambers—the rumen and the reticulum—begin to digest cellulose by releasing enzymes. Food enters the rumen from the esophagus and is later regurgitated and chewed further. It then enters the reticulum and passes to the omasum, where water is absorbed. The food then enters a fourth chamber, called the abomasum, which, like the stomach of other mammals, secretes gastric juice for chemical digestion. The rabbit, which also feeds on plant material, has an enlarged cecum with microorganisms that digest cellulose.

occurs inside the cell. Intracellular digestion is also found in some higher animals such as mussels and sponges. It occurs even in some animals that consume large pieces of food; the prey captured by *Hydra,* for example, is partially digested in the coelenteron, a gutlike cavity, and the digestion of the residue is then completed in cells of the body wall.

In most higher animals digestion is completed extracellularly in the cavity of a digestive tract (the STOMACH and INTESTINE). Animals with this type of digestion include crustaceans, insects, cephalopods, tunicates, and all vertebrates. A few animals with digestive tracts, however, also partially digest their food before eating it. Some spiders, for example, pierce their prey with fangs that pump digestive fluids into the victim. This liquefies the softer parts, which the spider then sucks into its stomach and intestine, where digestion is completed.

Digestive Enzymes

In digestion large molecules are split into smaller ones by ENZYME-catalyzed HYDROLYSIS, so named because water is taken up in the process. The enzymes that hydrolyze proteins, fats, and carbohydrates are called, respectively, proteases, lipases, and carbohydrases, or amylases.

Some insects, birds, and herbivorous animals can digest substances that most other animals cannot. The clothes moth digests hair and wool; termites digest wood; and herbivores digest plant cellulose. None of these organisms, however, produce the needed digestive enzymes, which are furnished instead by bacteria or protozoans, harbored in the digestive tract. Each termite species, for example, carries protozoans peculiar to it that change wood into digestible substances.

Herbivorous mollusks such as the snail produce their own cellulose-digesting enzymes, or cellulases, as does the shipworm, a wood-boring mollusk. No vertebrate produces cellulases. Initial stages of digestion in the cow and other ruminants are carried out by enzymes secreted by bacteria in the rumen, a large sac that precedes the true stomach. Plant fiber enters the rumen, is attacked by bacterial enzymes, and is then returned to the mouth for further chewing; the food so returned is called the cud. This chewing increases the surface area exposed to the bacteria.

The presence of digestive bacteria in ruminants results in a specialized metabolism of proteins and carbohydrates. Most of the ruminant's protein needs are actually supplied by the rumen bacteria, which use such simple substances as urea and inorganic sulfates to manufacture proteins. Ruminants digest these proteins and do not require in their diets certain amino acids (the basic building blocks of proteins) that are indispensable in the diets of other animals.

Most products of digestion are the same for all organisms: simple sugars from the hydrolysis of carbohydrates, fatty acids from fats, and amino acids from proteins.

The Gut

In amoebas a vacuole serves the same purpose as the intestine, or gut, in the higher animals. Some parasites need no gut but absorb material from the host through their external surfaces. Organisms below the evolutionary level of the flatworms have a single gut opening that connects with the environment. The single opening has a major drawback: until the residue of one meal is ejected, another meal cannot be consumed. To support a large body and maintain an active life, energy is needed at a rate that can be met only by a complicated digestive system: a tubular gut with two openings, mouth and anus, which allows feeding at will plus specialization of tissue for the sequential stages of digestion.

Digestive Glands

In animals with a tubular gut, digestive enzymes are produced and secreted by special glands. The glands near the mouth may supply the means of paralyzing prey, as in spiders and some snakes; maintaining the diet of vertebrate blood in a liquid state, as in leeches and some insects; binding and lubricating the food bolus, as in insects and many vertebrates; and keeping the mouth clean and beginning starch digestion, as in mammals.

In many species of invertebrates the middle portion of the gut has two large digestive glands that produce secretions effecting the digestion of carbohydrates, proteins, and fats. These glands serve functions similar to those performed by the exocrine pancreas in mammals. The liver in vertebrates produces bile, which aids in the absorption of fats in the gut.

The Absorptive System

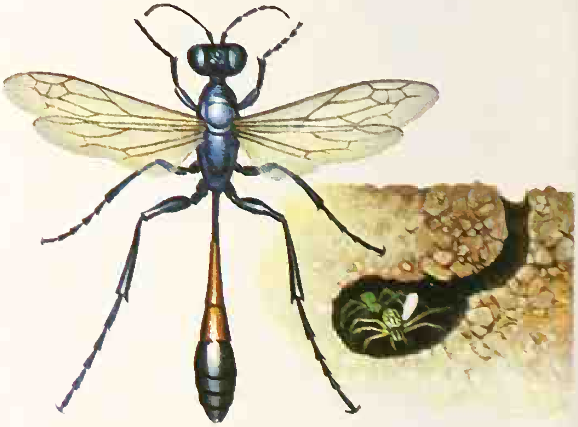
To attain sufficient rates of food absorption and energy production, a large animal must have a correspondingly large surface area of digestive tract. Increased surface area is attained by the coiling of a long gut within the body cavity; by the formation of folds of the epithelium, the lining or inner layer of the gut; and by fingerlike protuberances, or villi, on the folds.

See also: DIGESTION, HUMAN.

Digger Indians see PAIUTE

digger wasp

digger wasp Digger, or fossorial, wasps are solitary, ground-nesting insects in the order HYMENOPTERA. Generally the term refers to some members of a large family, the Sphecidae, which dig their nest in the soil. Other families of wasps that may excavate ground nests are Pompilidae, Eumenidae, and Masaridae. These wasps dig a chamber in the ground, place insect or spider prey in the cell (except for most Masaridae, which provide pollen), and then lay their eggs.



A digger, or thread-waisted, wasp has a slender stalk separating its thorax and abdomen. It burrows a cell in mud (right) *and seals a paralyzed insect in the cell along with its own egg. Once hatched, the wasp larva feeds upon the prey provided by its parent.*

digital computer see COMPUTER

digital technology

digital technology In a digital system, the representation of a natural phenomenon is made by measuring dynamic qualities of the phenomenon at discrete moments in time. The numeric values obtained in such measurements are then usually translated into base-2 values (see BINARY NUMBER). The digital approach to recording the behavior of natural events differs from that of analog technology mainly in this consideration of time (see ANALOG DEVICES). In an analog technology, time is continuously observed, whereas in a digital technology, time is sampled.

An automobile speedometer is a familiar example of a device that can employ either digital or analog forms. The needle of an analog speedometer often wobbles about listed values of the average speed as it responds to slight fluctuations in velocity. A digital speedometer, on the other hand, displays precise numeric values for time intervals.

A relationship between digital and analog representations is observed when one considers an analog technology as producing an infinite number of samples, implying that infinitesimally small amounts of time elapse between successive evaluations of the continuous variable. The digital notion follows directly from this idea by extending the time between successive samples. When this time becomes large, however, the opportunity arises for the true signal to change without being observed.

There are certain advantages to the digital form over the analog form. For example, simple means exist for saving lists of digital values and for performing computations on such lists. This is the basis for the digital COMPUTER. In addition, a complex event can be preserved in digital form and analyzed or reproduced on demand. Moreover, it is possible not only to process digitally encoded information that contains errors, but also to correct those errors.

Instances of the use of digital technology in an analog environment are becoming more common. Sound has usually been transmitted and preserved in analog form. However, COMPACT DISCS are digital storage devices that are replacing analog phonograph records because compact discs are less susceptible to unwanted sounds and to physical damage. In the modern telephone system, numerous conversations can now be placed in digital form, bundled together using a different time frame, transmitted by wire or optical fiber, and then unpacked to be sent to individual receivers. Like sound, light is also a signal that can be sampled. Photographic imaging, whether by a television camera or by a camera aboard a spacecraft, can employ digital technology whereby a picture is broken up into small dots, called pixels, with average values of light intensity assigned for each pixel (see CHARGE-COUPLED DEVICE).

digital-to-analog converter A digital-to-analog converter, abbreviated as D/A converter or DAC, converts digital representations of numbers into analog voltages or currents. DACs have many uses, including the conversion of numbers stored in a COMPUTER MEMORY into voltages for driving a CRT (cathode-ray tube) display. The digital representations being converted are usually in the form of BINARY NUMBERS, and a DAC's precision is given by the number of binary bits it can accept as input.

See also: ANALOG-TO-DIGITAL CONVERTER.

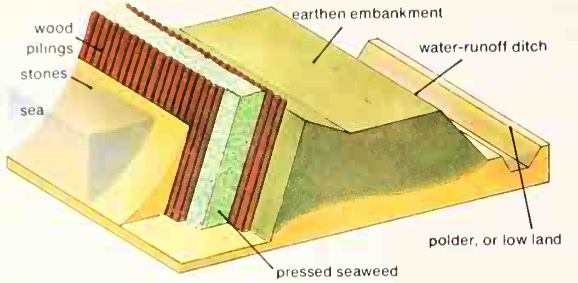
digitalis Digitalis is a drug that is a powerful stimulant of heart muscle contractions. Digitalis is frequently prescribed for the treatment of congestive heart failure despite potentially serious side effects. It increases the strength of muscle contraction to pump blood from the heart. The drug is a combination of ingredients derived from the FOXGLOVE plant, including digitoxin, the most active component.

See also: HEART DISEASES.

Dijon [dee-zhohn'] Dijon is the capital of Côte d'Or department in east central France and is located at the junction of the Suzon and Ouche rivers about 270 km (168 mi) southeast of Paris. The population of the city is 145,569 (1982); that of the conurbation is 215,865. The Burgundy Canal connects the city with the Asône River and with the rivers of the Paris Basin. Dijon is located in a rich agricultural area in the northern end of the famous BURGUNDY wine district. Cassis, a black currant liqueur, originated there, as did Dijon mustard. The city has a large printing industry and manufactures chemicals, electrical equipment, food products, leather products, automobiles, and a variety of machinery. The city contains many art treasures and renowned buildings such as the Musée des Beaux-Arts. The university was established in 1722. The site was first settled as a Roman camp, and Dijon became the capital for the dukes of Burgundy in 1016. It came under control of the French crown in the 15th century. Dijon was occupied by the Germans during World War II.

dik-dik Dik-diks are small ANTELOPES that live in semiarid regions of southern and eastern Africa. The two genera, *Madoqua* and *Rhynchotragus*, contain five species. The animals stand up to 40 cm (16 in) at the shoulder and weigh 3.5 kg (8 lb) or less. The adult females are slightly larger than the horned males. The coat is brown to grayish, and the forehead has a tuft of hair. Dik-diks live in pairs, marking the boundaries to their territory with dung, urine, paw scrapings, and—in the case of the male—secretions from glands in front of the eyes. The female bears one young at a time. Dik-diks have been hunted for their skin, used in making so-called "gazelle-skin" gloves.

dike (engineering) A dike is a long artificial barrier, commonly of earth, which is built to prevent flooding from high water in rivers or from ocean storms. A river dike is usually built of clay and sand with a grass-sod covering. The crown, or top, rises 1 to 1.5 m (3 to 5 ft) above the anticipated high-water level. Sea dikes are far more complicated in construction, since such factors as the length and strength of waves and the effects of storm winds on wave height must be considered in designing them. The crown of a sea dike is often 3 to 5 m (10 to 16 ft) above storm flood level. The outer, or ocean-facing, slope is pro-



During the Middle Ages, earthen sea dikes were protected against erosion on the sea side by the combination of a compacted layer of weeds supported by wood pilings and a cemented stone barrier.

tected with erosion-resistant materials—grass sod on the top and basalt stone or concrete blocks cemented with asphalt for the remainder of the slope. Sand may be hydraulically pumped inside the dike walls, and concrete caissons are often used to form the base of the dike. The entire structure may be reinforced with vertical steel sheet piling. The outer slopes of sea dikes often have protruding stones or are built in steps to reduce the length of waves as they run up against the dike walls.

Sea-dike design has been developed to a high degree of sophistication in the Netherlands, particularly in the construction of the huge flood-control project called the Delta Plan.

See also: coastal protection; floods and flood control; levee.

dike (geology) A dike is a tabular body of igneous rock that cuts across, or intrudes in, the rocks surrounding it. Dikes may have any orientation from vertical to horizontal, provided that they are discordant with respect to layers in the rocks they invade. (Intrusions that are concordant are known as sills.) Dike rocks that have crystallized near the surface of the Earth or cooled quickly tend to be fine grained; those which have crystallized deep within the Earth or cooled slowly tend to be coarser grained. The coarsest form a category of plutonic rocks called pegmatite. Dikes may be of any thickness, from a few millimeters to hundreds of meters.

See also: vein deposit.

dill Dill is an annual or biennial herb, *Anethum graveolens,* cultivated for its small fragrant fruits (dill seed) and leaves (dillweed). Whole fruits are used to flavor pickles, breads, and soups. The young leaves are used in salads, soups, meats, seafood, and eggs. The essential oil, obtained from both the fruits and leaves, is used in pickles, chewing gums, and candies. Dill is native to Southwest Asia and is cultivated in India, Europe, and the United States.

Dill, an herb of the carrot family, produces seeds and leaves that impart a tangy flavor to a great variety of foods, including pickles and soups.

Dillinger, John John Dillinger, b. Indianapolis, Ind., June 22, 1903, was an American bank robber who gained national attention in the 1930s when the Federal Bureau of Investigation named him "public enemy number one." At the age of 21 he was caught robbing a grocery store and spent 9 years in prison. On his release he became leader of a gang that held up banks in the Midwest. He twice escaped jail. In April 1934 he fought his way out of a police trap in Wisconsin, killing two men. He died on July 22, 1934, when a woman friend betrayed him and he was gunned down by the FBI as he emerged from the Biograph Theater in Chicago. A legend arose that another man was killed in his place and that Dillinger escaped.

Dillon, C. Douglas Clarence Douglas Dillon, b. Geneva, Switzerland, Aug. 21, 1909, served (1961–65) as U.S. secretary of the treasury under Presidents John F. Kennedy and Lyndon B. Johnson. An international financier, he was also ambassador to France (1953–58), undersecretary of state for economic affairs (1958–59), and undersecretary of state (1959–61). Long a patron of the arts, Dillon was chairman of the board of trustees of the Metropolitan Museum of Art from 1977 to 1983.

Dilmun [dil'-muhn] Dilmun is the Sumerian name of an ancient trading center identified with the present-day island of Bahrain, in the Persian Gulf. The name also refers to a legendary holy land mentioned in Sumerian mythological texts. It supplied Sumer with copper ore and copper objects, precious stones, stone beads, pearls, wood, dates, and onions in exchange for agricultural and dairy products. Dilmun retained its position as a major center of sea trade into the early 2d millennium.

DiMaggio, Joe Joseph Paul DiMaggio, b. Martinez, Calif., Nov. 25, 1914, was professional baseball's pre-

Joe DiMaggio, a centerfielder for the New York Yankees, is remembered as one of the most graceful athletes ever to play baseball. DiMaggio won the American League's batting championship twice and was voted its Most Valuable Player in 1939, 1941, and 1947.

mier center fielder during the late 1930s and the 1940s. Playing his entire major-league career (1936–42, 1946–51) for the New York Yankees, DiMaggio was a dangerous batter and one of the most graceful and fleet outfielders ever to play the game—hence his nicknames, Joltin' Joe and the Yankee Clipper.

In 1936 the Yankees purchased DiMaggio from the San Francisco Seals of the Pacific Coast league, where at age 18 he had compiled a 61-game hitting streak. He would go on to lead the American League twice in home runs (1937, 1948), batting average (1939–40), slugging average (1937, 1950), and runs batted in (1941, 1948). He was three times voted the league's Most Valuable Player (1939, 1941, 1947), and in his 13 seasons he led the Yankees to 10 pennants and 9 World Series titles. His greatest, and as yet unapproached, achievement came in 1941, when he hit safely in 56 consecutive games. DiMaggio finished his career with a .325 batting average, 2,214 hits, 361 home runs, and 1,537 runs batted in. He was elected to the Hall of Fame in 1955.

dimagnetism see MAGNETISM

dimension Dimension, in GEOMETRY and mathematics in general, is a property of space. The word *dimension* is also used more broadly in science, as in common language, to indicate some variable property or factor that is measurable.

Mathematically, a space is defined by the number of its dimensions. This number is the smallest number of coordinates needed to locate a point within that space (see COORDINATE SYSTEMS). Thus three and only three coordinates are needed in ordinary, three-dimensional space. In a room, for example, a point is located in reference to the *x*, *y*, and *z* axes that represent the height, breadth, and depth of the room. On a surface, or plane, only two coordinates are needed, so figures on a plane are two-dimensional. A point on a line can be located by one coordinate, so a line is one-dimensional. A point is itself a nondimensional concept.

In RELATIVITY theory the space-time continuum of the universe is said to be four-dimensional because time is treated as a fourth coordinate required to locate an object within the continuum. This is only one example of the abstract spaces of *n* dimensions used in advanced mathematics (see TOPOLOGY) and in the mathematical treatment of some branches of physics, such as particle physics. These "spaces" cannot be conceived of in terms of ordinary, three-dimensional reality. They may instead be thought of as the complex coordinate systems required in the pursuit of such areas of study.

Dimetrodon [dy-met'-roh-dahn] *Dimetrodon* (Greek: *di*, "double"; *metron*, "measure"; *odōn*, "tooth"), an extinct genus of pelycosaurian reptiles, was the dominant carnivore in river deltas of the southwestern United States during the Permian Period of GEOLOGIC TIME. Species ranged in length from 1.7 m (5.6 ft) to 3.3 m (10.8 ft) and weighed up to 254 kg (560 lb). The body, with large head, short neck, and long tail, resembled that of EDAPHOSAURUS, a herbivorous reptile. The main distinguishing feature of *Dimetrodon* was a bizarre dorsal fin, as much as 1.2 m (3.9 ft) high, supported by long, slender, vertebral spines. Paleontologists have suggested that with a copious blood supply, the fin could have served as a temperature-control device. According to how they positioned their bodies to the Sun's rays, these cold-blooded animals could have used their fins to gain or lose body heat.

Dimitrov, Georgi Mikhailov [di-mee'-trahf, geh-or'-gee mik'-hy-lawf] Georgi Mikhailov Dimitrov, b. June 18, 1882, d. July 2, 1949, was a Bulgarian Communist leader and founder of the People's Republic of Bulgaria. A left-wing socialist from 1902, he was elected to the Bulgarian National Assembly in 1913 but was imprisoned for opposing Bulgaria's entry (1915) into World War I. In 1923 he led an abortive Communist uprising in Bulgaria. Fleeing abroad, he served as an officer of the Comintern and in 1933 was tried (and acquitted) for alleged involvement in the burning of the German REICHSTAG. Dimitrov was secretary-general of the COMINTERN from 1935 to 1943. Returning to Bulgaria, he became premier on the abolition of the monarchy in 1946 and presided over the creation of the one-party Bulgarian state.

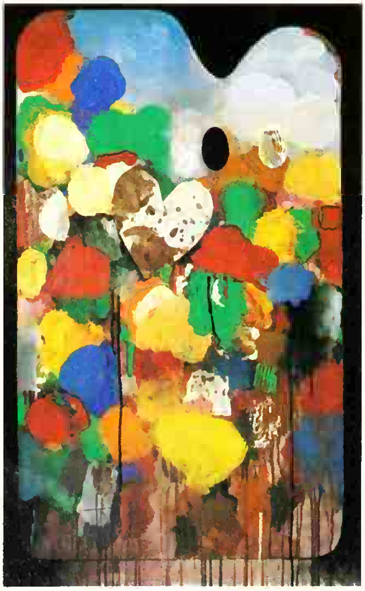
Dimitry Donskoi, Grand Duke of Moscow [di-mee'-tree dahn-skoy'] Dimitry Donskoi, b. 1350, d. May 19, 1389, grand duke of Moscow (1359–89), first broke the tradition of submission to the Khanate of the GOLDEN

Horde. On Sept. 8, 1380, Dimitry led the Russian princes to victory over the Tatars on the plain of Kulikovo on the upper Don River. Although this victory did not end the Tatar domination over Russia, it enhanced the prestige of the grand duke of Moscow. Dimitry, the son of Ivan II (r. 1353–59), also enlarged the territory of Moscow considerably and helped prevent an invasion by Lithuania.

Dinaric Alps [dy-nair'-ik] The Dinaric Alps (Serbo-Croatian: Dinara Planina) are a 644-km (400-mi) extension of the Eastern Alps that parallels the Adriatic coast of Yugoslavia from Istria to northern Albania. The rugged limestone range reaches its maximum height of 2,693 m (8,833 ft) in Jezerce in Albania. Access to the interior is difficult, and the range is sparsely populated.

d'Indy, Vincent see Indy, Vincent d'

Dine, Jim Jim Dine, b. Cincinnati, Ohio, June 16, 1935, is a leading American artist, whose work includes painting, sculpture, drawings, prints, and theater design. His style combines gestural painting with representational imagery. In the early 1960s, Dine's works were "object paintings," assemblages of such items as toothbrushes, tools, and so on, put into contexts that reflected his interest in pop art, but his later works are more traditional paintings. His choice of popular imagery is autobiographical and is explored in large series of vividly colored paintings, prints, and drawings. Dine's theatrical work—beyond his participation in earlier happenings—includes designing costumes, sets, and props for *A Midsummer Night's Dream* (1966) and *The Picture of Dorian Gray* (1968). Much of his work of the 1970s and '80s represents a new direction toward figural composition.



Jim Dine's Palette of Pleasure *is one of a series of palettes, studies, and self-portraits done by this contemporary American artist. (Wallraf Richartz Museum, Cologne.)*

The Danish writer Isak Dinesen is known for her Gothic short stories featuring eerie, supernatural motifs. Her finest full-length work, Out of Africa *(1937), is based on Dinesen's experiences as the owner of a coffee plantation in Kenya.*

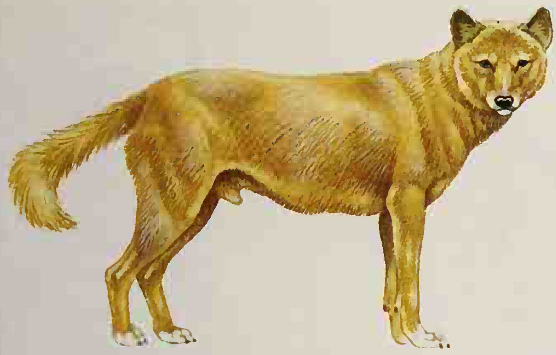
Dinesen, Isak [dee'-nuh-suhn, ee'-sahk] Isak Dinesen is the pseudonym of Baroness Karen Blixen-Finecke, b. Apr. 17, 1885, d. Sept. 7, 1962, a Danish author known for her short stories and accounts of experiences on a coffee plantation in British East Africa, now Kenya. She married Baron Bror Blixen-Finecke in 1914, was divorced in 1921, and managed the plantation alone until 1931.

While in Kenya, Dinesen wrote *Seven Gothic Tales* (1934), published in English under her maiden name of Dinesen and widely acclaimed by critics. She later translated the work into her native Danish. *Out of Africa* (1937; film, 1985) recounts Dinesen's years in Kenya and was written in both Danish and English. It was followed by two more collections, *Winter's Tales* (1942) and *Last Tales* (1957).

Dinesen's short stories are works of art consciously written in the tradition of the 18th-century Gothic novel. They blend romance and realism, showing a subtlety of mood and an awareness of the psychology of the human spirit.

dinghy The term *dinghy* is applied to various small boats. In India, dinghies equipped with oars or sails transport passengers and cargo. The dinghies that serve as ships' boats were originally rowboats with rounded bow and two to four oars but now are usually powered and have a pointed bow. A small, open sailboat used as a tender and lifeboat for a yacht is also referred to as a dinghy, as is an inflatable life raft. Racing dinghies are equipped with sail and rudder and sometimes a centerboard.

dingo The dingo, or Australian wild dog, *Canis dingo,* belonging to the dog family Canidae, is one of the few Australian mammals that is not a marsupial. It stands about 60 cm (2 ft) tall at the shoulder and is 120 cm (4



The dingo, the Australian wild dog, is believed to have been brought to Australia by the Aborigines. Although it preys on sheep, the dingo is helpful in controlling the rabbit population.

ft) long, including a bushy 30-cm (12-in) tail. The muzzle is broad and heavy, the legs long, and the paws large. The short coat is tawny brown with whitish underparts. The Aborigines are believed to have introduced the dingo when they came to Australia approximately 30,000 years ago. Dingoes hunt singly or in small packs, killing wallabies, rabbits, sheep, and poultry. A litter has six to eight pups in it.

Dinis, King of Portugal Dinis, b. Oct. 9, 1261, d. Jan. 7, 1325, the son and successor of King ALFONSO III, ruled Portugal from 1279 to 1325. He became known as "the farmer" because of his interest in agriculture. Dinis had swamps drained, forests planted, and large estates broken up and distributed among the peasants. He also encouraged fairs, shipbuilding, and commerce with France, England, Italy, and Flanders. A cultured man, he made Portuguese the official language of the judiciary and founded (1290) Portugal's first university, at Lisbon. He ended the long dispute between crown and church with the Concordat of 1290.

Dinkins, David David Norman Dinkins, b. Trenton, N.J., July 10, 1927, became mayor of New York City on Jan. 1, 1990. The city's first African-American mayor, Dinkins rose through the political ranks of the local Democratic party, beginning with involvement in clubhouse politics in Harlem in the 1950s. Over the years he held a variety of city positions while also pursuing a law career. He was president of the borough of Manhattan from 1986 to 1990. He also had served in the New York State Assembly (1965–67). Considered New York's most liberal mayor in nearly 20 years, Dinkins faced severe budget constraints and a high level of racial tension in the city.

dinoflagellate [dy-noh-flaj'-uh-lat] Dinoflagellates are motile, usually unicellular ALGAE belonging to the division Pyrrhophyta and probably second in importance only to the diatoms as primary photosynthesizers of organic matter in the oceans. They are the most conspicuous algae in the phytoplankton, but some zoologists still consider them in their former classification as protozoans. Some genera, such as *Gonyaulax* and *Gymnodium*, contain a red pigment and produce a potent nerve toxin; when the organisms occur in great abundance they produce the so-called RED TIDES that can kill millions of fish. Humans can get paralytic poisoning by eating seafood contaminated with dinoflagellate toxin.

Members of the dinoflagellate group have two flagella, or hairlike projections, one of which extends beyond the cell like a tail while the other encircles the cell like a belt. Throughout their existence, almost all forms are solitary and swim by means of their flagella. Reproduction may be vegetative, asexual, or sexual (after a conjugation tube is formed between individuals). Some genera, such as *Ceratium*, occur in marine and freshwater forms. In lakes *Ceratium* may produce a colony, or bloom, of great numbers that changes the color of the water to coffee brown.

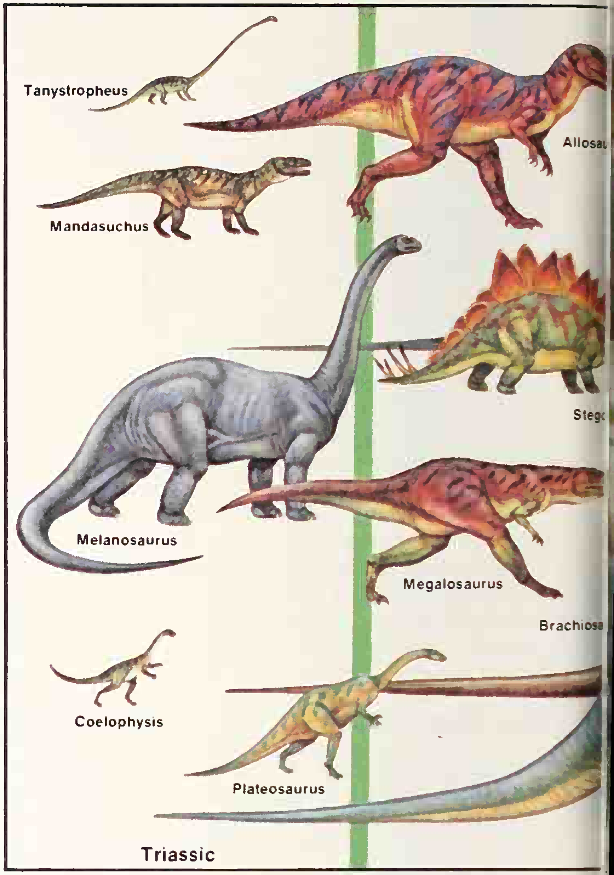
dinosaur Dinosaur (Greek for "terrible lizard") is the name given to various kinds of large extinct reptiles of the Mesozoic Era (from 230 to 65 million years ago), the interval during which they were the dominant land animals on Earth. The term was proposed as a formal zoologic name in 1841 by the British anatomist Sir Richard Owen, in reference to large fossil bones unearthed in southern England, but it is used today only in an informal sense. The various kinds of dinosaurs are classified in two formal categories, the orders Saurischia and Ornithischia, within the reptilian subclass Archosauria.

The first recorded dinosaur remains found consisted of a few teeth and bones. They were discovered (1822) in Sussex, England, by an English doctor, Gideon Mantell, who named them IGUANODON ("iguana tooth"). About the same time, other fossil teeth and bones were found near Oxford, England, by Rev. William Buckland. These were named *Megalosaurus* ("great lizard"). Thousands of specimens have since been discovered nearly worldwide.

Different types of dinosaurs varied greatly in form and size, and they were adapted for diverse habitats. Their means of survival can be inferred from their fossil remains only, and some inferences are in dispute. They ranged in weight from 2 to 3 kg (4 to 6 lb), in the case of COMPSOGNATHUS, and up to 73 metric tons (160,000 lb), in the case of BRACHIOSAURUS. Most dinosaurs were large, weighing more than 500 kg (1,100 lb), and few weighed less than 45 kg (100 lb). Most were herbivores, but some saurischians (the theropods, for example) were carnivorous. The majority were four-footed, but some ornithischians (the ornithopods, for example) and all carnivores strode on their hind legs.

Always classified as reptiles, dinosaurs have traditionally been assumed to have been reptilian in their physiology, cold-blooded and ectothermic (dependent on external heat sources). In recent years several different lines of evidence have been interpreted as indicating that dinosaurs may have had warm blood and high rates of metabolism, comparable to birds and mammals. Evidence sup-

Dinosaurs dominated the land for approximately 140 million years during the Mesozoic Era. They varied in size from the Compsognathus*—no larger than a domestic chicken—to* Diplodocus *(almost 27 m/90 ft long) and* Brachiosaurus *(known to exceed 50 tons). Representative genera are arranged according to the approximate time during which they existed; all are drawn to scale.*



porting this view includes upright posture and carriage; mammallike microscopical structure of bones; skeletal features suggestive of high activity; and specialized food-processing dentitions and low ratios of dinosaurian predators to prey animals, both suggesting high food requirements. The evidence is not conclusive—all the facts can be alternatively explained—but some dinosaurs may have been endothermic (maintaining body temperature and heat production by internal metabolic processes).

The reproductive means of most dinosaurs is as yet unknown. Fossil eggs, attributed to one of the horned dinosaurs (PROTOCERATOPS) and a sauropod (*Hypselosaurus*), have been discovered in Mongolia and France. Fragments that are presumed to be of dinosaur eggs have also been found in Brazil, Portugal, Tanzania, and the U.S. states Colorado, Montana, and Utah. In Montana, Utah, and Alberta, Canada, fossils of unhatched dinosaur eggs have been discovered. This evidence indicates egg-laying (oviparous) reproduction in dinosaurs, like most modern reptiles. A few scientists believe that some dinosaurs may have given birth to living young, but no conclusive evidence has yet been found to substantiate this.

The two orders of dinosaurs are distinguished by numerous features, the most diagnostic being the arrangement of the three bones of the PELVIS. In saurischians, these bones were arranged in a triradiate pattern similar to that of modern crocodilians and lizards; the term Saurischia means "lizard hip." The ornithischian pelvis was usually rectangular or tetraradiate; hence the name, which means "bird hip."

Saurischia

The order Saurischia includes two different kinds of dinosaurs: the carnivores (suborder Theropoda); and the huge herbivores, and their ancestors, suborder Sauropodomorpha. Aside from the saurischian pelvic arrangement, the two groups had few anatomical features in common.

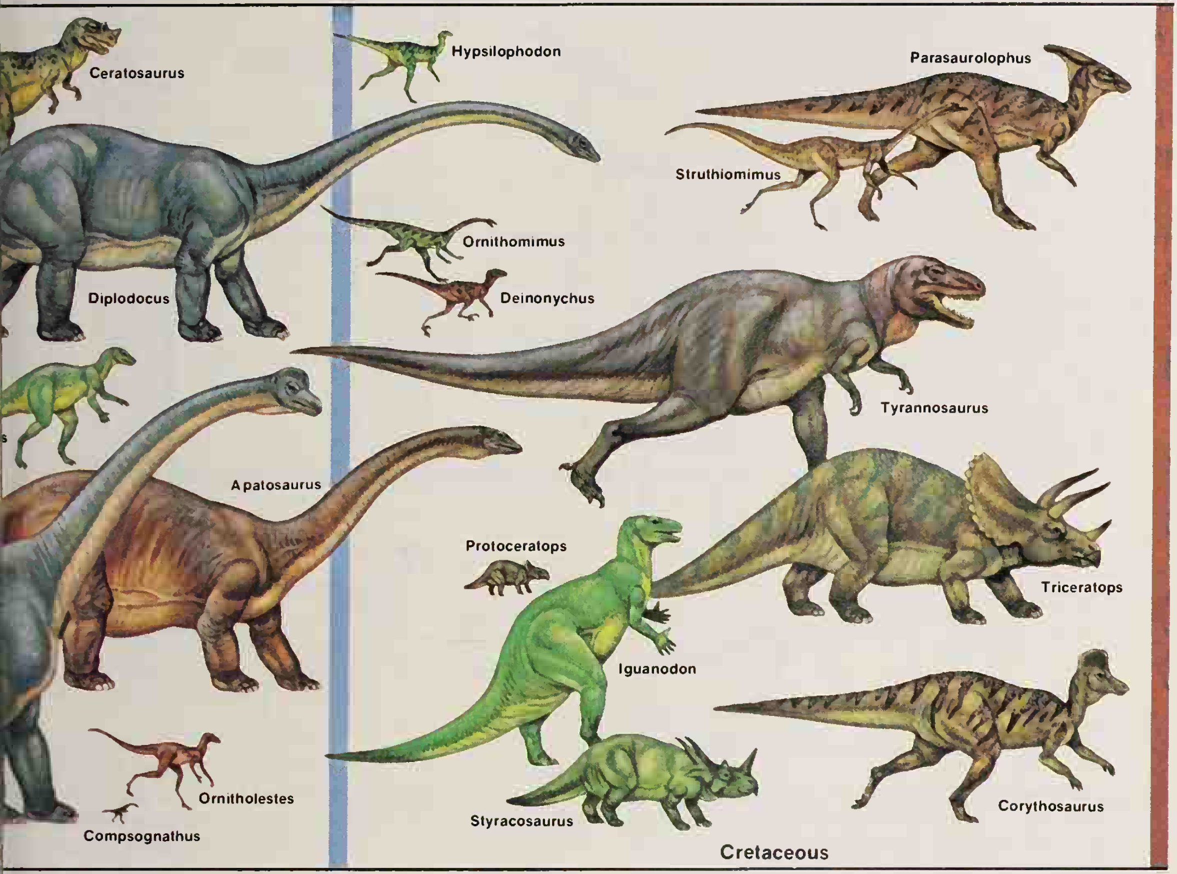
Theropods. The theropods are subdivided into two categories, the small and lightly built coelurosaurs and the large and heavily built carnosaurs. Some evidence indicates that this subdivision may be arbitrary and may not accurately represent evolutionary relationships among the theropods.

All theropods were obligatory bipeds—unable to assume a four-legged stance. The hind legs were strong and bore birdlike feet. In some, the hind-limb proportions indicate high running speed. The forelimbs bore sharp, curved claws for seizing and holding prey. All theropods had long tails that functioned as dynamic stabilizers or counterbalances. The head was relatively large to huge, and the jaws of most contained numerous sharp, bladelike teeth with serrated edges—clear evidence of flesh-eating habits. The "ostrich" dinosaur (*Struthiomimus*), however, had toothless jaws that probably were covered with a birdlike beak—evidence that perhaps all theropods were not carnivorous.

The smallest known theropod is *Compsognathus* (Late Jurassic, Europe) and the largest is *Tyrannosaurus* (Late Cretaceous, North America), which grew to a weight of 5 or 6 metric tons (about 10,000 lb), a height of 6 m (18 ft), and a length of 15 m (45 ft). First appearing in mid-Triassic, theropods thrived until the end of the Cretaceous.

Sauropods. The suborder Sauropodomorpha comprises two subcategories: the Sauropoda, all of which resembled the best-known member of their group, APATOSAURUS, and the Prosauropoda, their less well-known, earlier relatives.

Prosauropods were common during the last part of the Triassic and have been found on all continents except Antarctica and Australia. Except for certain resemblances in the skull and teeth, they were quite different from the sauropods. The prosauropods were much smaller, ranging from a few hundred kilograms to perhaps 1,500 kg (3,300 lb). All were quadrupedal, but many were capable of bipedal posture and gait. They all appear to have been herbivores, although carnivorelike teeth have been found associated with skeletal remains of some kinds. Best



known of the prosauropods is Plateosaurus (Late Triassic, Europe).

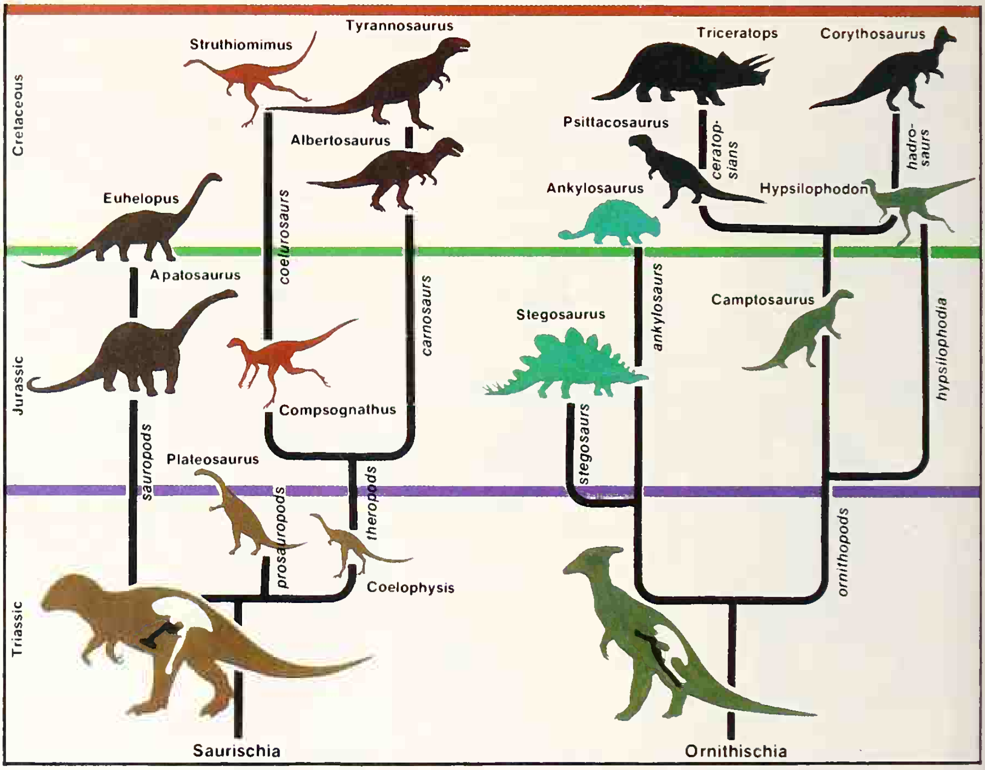
Once considered semiaquatic or amphibious, the sauropods include the largest of the dinosaurs. The smallest varieties were larger than elephants, and the largest, *Brachiosaurus* (Late Jurassic, East Africa) and a new, unnamed discovery, are estimated to have weighed 73 metric tons (about 160,000 lb) or more. Best known are *Apatosaurus* (incorrectly, *Brontosaurus*) and Diplodocus from the Late Jurassic of North America. All sauropods had the same basic structure: large, barrellike body; sturdy, columnar legs; long, heavy tails; and a small head at the end of a long and stout neck. The hypothesis that the sauropods lived in semiaquatic swamp environments came from the notion that their limb bones were not strong enough to support such weights without the buoyant effect of water, and that the long necks enabled them to reach the surface for air. Water pressure, however, would not have permitted their lungs to function at such depth. Footprints show that sauropods could travel across land, and the long necks probably enabled them to browse from trees. The sauropods were dominant herbivores in the Jurassic but apparently were of minor importance in the Cretaceous.

Ornithischia

The Ornithischia are divided into four or five suborders; the four always included are the bipedal ornithopods, the plated stegosaurs, the armored ankylosaurs, and the horned dinosaurs, or ceratopsians. Some authorities put the dome-headed, bipedal pachycephalosaurs in a fifth suborder, rather than in the Ornithopoda. In addition to the birdlike pelvis common to the ornithischians, all except a few primitive kinds had a toothless front part of the mouth, which was covered by a horny beak or bill.

The ornithopods were the most successful and diverse of the ornithischians. The earliest are Middle and Late Triassic in age (*Pisanosaurus,* South America; *Heterodontosaurus,* Africa). At the close of the Cretaceous, 140 million years later, ornithopods were the most abundant of the herbivores. All were adept bipeds, but they were also able to assume a four-legged stance and gait. The most interesting feature of the ornithopods is the specialized teeth many had for crushing and grinding plant material. This dental apparatus was most highly developed in the Late Cretaceous duck-billed dinosaurs (*Corythosaurus*, *Anatosaurus*). Their grinding dental batteries composed of hundreds of tightly compacted teeth

The dinosaur family tree is divided into two orders, primarily according to the arrangement of the pelvic bones: the Saurischia, or lizard-hipped dinosaurs, and the Ornithischia, or bird-hipped dinosaurs. Representative dinosaurs are not drawn to scale.



are evidence of high food-volume intake, related perhaps to high metabolism. Aside from *Camptosaurus* (Late Jurassic, North America) and *Iguanodon* (Early Cretaceous, Europe), the duck-bills of Asia and North America are best known.

The plated dinosaurs (Stegosauria) were never as important as the other dinosaurs. The few fossils found have been in Jurassic rocks, mostly from North America, East Africa, and Europe. Like all other ornithischians, they were herbivores, but with a small head and few small teeth that seem strangely designed to feed the animal's large body. The distinctive feature of Stegosaurus is the row of alternating upright bony plates that developed along the back. Long thought to have been protection against predators, these plates have recently been shown to be highly vascularized and probably heavily suffused with blood during life. This has led to the suggestion that they may have been cooling fins and functioned as temperature regulators.

The Ankylosauria succeeded the stegosaurs in the Cretaceous, apparently filling that vacated niche. To varying degrees, all ankylosaurs were encased in a mosaicwork shield of bony plates and spikes that covered the back and flanks. All were relatively low, broad animals with short, pillarlike legs. The large body indicates a herbivorous diet, but the small, weakly developed teeth seem inconsistent with the necessary food intake. Palaeoscincus and Ankylosaurus (Late Cretaceous, North America) are the best-known examples.

The horned dinosaurs (Ceratopsia) were the last of the major dinosaurian kinds to appear. The earliest-known kind, *Protoceratops*, a low-slung, calf-sized animal, is known only from the Upper Cretaceous rocks of the Gobi Desert, Mongolia. It probably descended from an earlier Mongolian ornithopod dinosaur, resembling the bipedal *Psittacosaurus*. Although all other horned dinosaurs arose from that Asiatic beginning, they have been found only in North America. Horned dinosaurs with large head and neck shields and horns evolved in North America, culminating in Triceratops and *Torosaurus*—two of the last surviving dinosaurs. Ceratopsians also bore specialized dental batteries for slicing, rather than grinding, plant food—further evidence of high food-volume requirements among some dinosaurs.

Evolution and Extinction

Dinosaur origins are uncertain, although most authorities agree that both orders arose from an extinct group of primitive reptiles known as the thecodonts. The pronounced anatomical differences between ornithischians and saurischians may be evidence of separate thecodont ancestry. The pseudosuchian thecodonts *Ornithosuchus* and *Euparkeria* are often cited as likely anatomical types that could have given rise to saurischians, and possibly ornithischians, but the evidence is too fragmentary to be conclusive.

During the 140-million-year reign of the dinosaurs, many new varieties evolved, and older kinds died out. Not all kinds became extinct at once, but the last of the dinosaurs disappeared at the end of the Cretaceous. Their EXTINCTION has been attributed to causes ranging from increases in cosmic radiation to changes in climate, to volcanic activity, to CONTINENTAL DRIFT. In fact, evidence indicates that sea levels did fall and temperatures drop at the end of the Mesozoic Era.

A controversial extinction theory was proposed in the 1980s by two physicists. Luis Walter ALVAREZ and his son, Walter, found a larger-than-normal amount of iridium in samples of sedimentary layers between rocks of the Cretaceous and Tertiary period and concluded that the iridium came from outer space, most likely from an asteroid that struck the Earth at that time. They theorized that the impact caused an enormous cloud of dust to circle the Earth, striking at the food chain (including the dinosaurs) by killing many plants. Other scientists later suggested that such a collision would instead have caused the extinctions by setting off massive fires. Many geologists, while accepting the iridium evidence as meaningful, have suggested that the iridium resulted from climate-changing volcanic eruptions over a longer time period.

Whatever the cause, the dinosaurs are now gone. In a way, however, they may remain. That is, many paleontologists consider birds almost certainly to have evolved from some small bipedal dinosaur during the Jurassic. If so, the children of the dinosaurs still exist today.

See also: EVOLUTION; FOSSIL RECORD.

Dinosaur National Monument Dinosaur National Monument, located on both sides of the Colorado-Utah state border, covers 836 km^2 (323 mi^2). It is known for the many dinosaur remains found in an outcropping discovered there in 1909 and for several spectacular canyons created by the Green River and its tributary, the Yampa. The canyons, the highest of which is the Canyon of Lodore (1,020 m/3,350 ft deep), contain evidence of prehistoric Indian life. The area became a national monument in 1915.

Dinwiddie, Robert [din-wid'-ee] Robert Dinwiddie, b. Oct. 3, 1692, d. July 27, 1770, spent most of his life as a British colonial administrator. After serving a brief time in his father's merchant house, Dinwiddie became a customs collector in Bermuda (1727–38), then surveyor general for the Southern District of America (1738–49), and, finally, lieutenant governor of Virginia (1751–58).

As lieutenant governor Dinwiddie was actually chief executive of Virginia since the governor never visited the colony. One of his principal tasks was to strengthen Virginia's defenses along the frontier. This occasionally brought him into conflict with a young army officer named George WASHINGTON, whom he sent first (1753) to warn the French against encroachment and later (1754) to defend the border at the Forks of the Ohio. Dinwiddie left Virginia on Jan. 12, 1758, to be succeeded by Francis Fauquier.

The Roman emperor Diocletian (r. 284–305) appears on this silver-coated bronze coin, a common form of currency abolished through sweeping monetary reforms in AD 294.

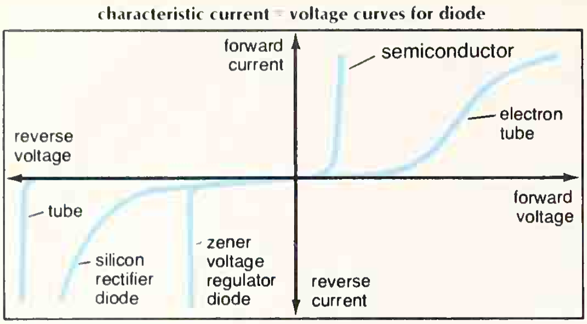
Diocletian, Roman Emperor Diocletian (Caius Aurelius Valerius Diocletianus), b. AD 245 in Dalmatia, d. 313, was one of the ablest Roman emperors. He rose through the military ranks to become commander of the emperor's bodyguard and was chosen by his fellow soldiers to succeed Numerian as emperor in 284.

Recognizing that the task of governing the Roman Empire had become too taxing for one man, Diocletian divided the empire into four administrative districts and agreed to share the management of these with three colleagues—MAXIMIAN, GALERIUS, and CONSTANTIUS I. By 298 this tetrarchy (rule of four) had suppressed rivals within the empire and defeated the barbarian tribes and the Persians who threatened the border provinces.

A remarkable administrator, Diocletian sponsored a series of reforms to rehabilitate imperial institutions. He reorganized provincial administration, increased the size of the army and made it more mobile, imposed a uniform system of taxation, and attempted to halt inflation by reforming the coinage and issuing (301) an edict prescribing maximum prices and wages. A less constructive measure was his persecution of the Christians in 303.

In 305, Diocletian voluntarily retired to his magnificent palace at Salona (modern Split, in Yugoslavia) and refused to participate in the civil war that followed.

diode [dy'-ohd] A diode is an electronic device with two terminals that allows a current through it in only one direction, depending on the polarity of the voltage connected across it. It may be either an ELECTRON TUBE or a SEMICONDUCTOR device.



characteristic current – voltage curves for diode

Diode currents increase with small increases in forward voltages but remain small with reverse voltages, except at high levels. Zener diodes maintain a constant voltage over a range of current flows.

History. In 1883, Thomas EDISON discovered that a heated metal (CATHODE) will give off ELECTRONS and that these electrons will move toward an unheated plate (anode) when the two elements are placed in an evacuated tube. Sir Ambrose FLEMING, developed (1904) the first practical electron-tube diode. Modern semiconductor diodes owe their development to the invention of the TRANSISTOR in 1948.

Operation. The electron-tube diode uses a heated cathode to emit electrons. Since the electrons have a negative charge, they will move through the vacuum to the anode if the anode is positive. This flow of electrons constitutes a current and will take place whenever the anode is positive with respect to the cathode. If the anode is negative, the electrons will not move through the tube, and there will be no current. If an alternating voltage—one whose polarity reverses regularly—is connected across the diode, there will be a current through the diode for only half of each cycle, that is, only when the applied voltage makes the anode positive with respect to the cathode. This process, converting AC to DC, is known as rectification and is performed by a device called a RECTIFIER. Rectification is the single most important application for diodes.

A semiconductor diode, typically made from silicon, is very small (approximately a 3-mm/0.12-in cube). No heat is required, and it is much more rugged than a tube. Basically, the solid-state diode consists of pure silicon with each end modified by the addition of some "impurity" material. This arrangement produces a P-type anode, in which holes, or positive charges, conduct current, and an N-type cathode, in which free electrons supply conduction. The area at which the P- and N-types meet is called a PN junction. If this junction is forward-biased, by connecting a positive voltage to the anode (P-type) and the negative voltage to the N-type, then holes and electrons can cross the junction and produce a current. If the opposite voltage is applied—a condition of reverse bias—there is no current.

Applications. If a single diode is connected in series with an AC supply voltage and a load, such as a battery to be recharged or a DC motor, half-wave rectification results. If two diodes are used with a center-tapped transformer, full-wave rectification is obtained. In this case the current drops to zero only momentarily each half-cycle. By using a device called a FILTER, this current may be smoothed to give a more steady value of DC. This constitutes a DC power supply.

In a ZENER DIODE the voltage across the diode is constant, independent of the current through the diode. This characteristic is used in a VOLTAGE REGULATOR to maintain a voltage from a power supply at some relatively constant value even though the load current may vary widely.

Some types of diodes are used for applications other than rectification. If the PN junction is manufactured from gallium arsenide phosphide (GaAsP), visible light will be emitted from the junction when a current is made to pass in the forward-biased direction. Such a light-emitting diode (LED) may produce red, yellow, or green light. LEDs are used as indicators on electronic equipment and in digital displays.

If light is allowed to fall on the junction of a reverse-biased PN diode, the current will be proportional to the amount of light. This is called a photodiode and is used in applications involving solar energy (see SOLAR CELL).

A tunnel diode is a forward-biased PN junction diode in which the two sides of the junction have been "doped" with impurities so that the electrical-charge differential between them is very small. These diodes transfer electrons over short distances and are therefore useful as fast switches in digital signal processing.

Diogenes of Apollonia [dy-ah'-jen-eez, ap-uhloh'-nee-uh] Diogenes was a Greek philosopher of the 5th century BC. An eclectic, he is remembered for his synthesis of two pre-Socratic philosophers, ANAXIMENES and ANAXAGORAS. In his *Peri physeōs* (On Nature), he suggested that all things come from air, and that air is an intelligent god ensuring order in the universe. He made extensive biological studies to support this idea, showing that air is the essential ingredient of life. Diogenes was ridiculed for holding this theory by Aristophanes in the play *Nephelai* (*The Clouds*).

Diogenes of Sinope Diogenes of Sinope, d. *c.*320 BC, was a Greek philosopher, perhaps the most noted of the CYNICS. He pursued the Cynic ideal of self-sufficiency, a natural life not dependent on nonessential luxuries. A student of Antisthenes, he is credited with the development of the *chreia* (moral epigram). He made his life a protest against what he thought of as a corrupt society. He is said to have gone about Athens with a lantern in the daytime, claiming to be looking for an honest man—but never finding one. In later art, Diogenes is often depicted in a torn cloak, with a dog, carrying a lantern.

Dion of Syracuse [dy'-uhn] Dion, *c.*408–354 BC, brother-in-law of DIONYSIUS THE ELDER of Syracuse, brought the philosopher PLATO to Sicily to educate his nephew DIONYSIUS THE YOUNGER in politics. The young Dionysius, however, banished Dion in 366. Dion returned and gained power in 357 but was assassinated three years later by an Athenian.

Dionne, Marcel Marcel Elphege Dionne, b. Drummondville, Quebec, Aug. 3, 1951, was one of the most prolific scorers in National Hockey League history. At his retirement—after a long career with the Detroit Red Wings (1971–75), Los Angeles Kings (1975–87), and New York Rangers (1987–89)—Dionne had accumulated 731 goals (2d all time) and 1,040 assists (3d) for 1,771 points (3d). The center led the NHL in scoring only once (1980), but won the Lady Byng trophy for sportsmanship twice (1975, 1977).

Dionysius the Elder, Tyrant of Syracuse [dy-uh-nish'-ee-uhs] Dionysius the Elder, *c.*432–367 BC, ruled the Greek colony of SYRACUSE in Sicily from 405 until his death. After seizing power, he fought against the Carthaginians who occupied a large part of Sicily. In the second war (382–375? BC), he was defeated and had to pay tribute to Carthage. Despite this, his reign was prosperous. He was a patron of the arts, erected many buildings, and made his fleet the most powerful in the Mediterranean.

Dionysius Exiguus [ek-sig'-yue-uhs] Dionysius Exiguus ("the Little"), *c.*500–26, a Scythian monk living in Rome, first introduced (525) the current chronology dating the Christian era from the birth of Christ (see CALENDAR). He is notable also for his compilations of the apostolic canons, the decrees of the early Eastern ecumenical councils, and the decretals of several popes.

Dionysius the Great Dionysius the Great, *c.*190–265, also called Saint Dionysius of Alexandria, was bishop of Alexandria from 247 until his death. A renowned theologian, he participated in various doctrinal disputes. During his vigorous opposition to SABELLIANISM, which denied the reality of the three persons of the Trinity, he was accused of tritheism, belief in three gods. He is one of the fathers of the church. Feast day: Nov. 17.

Dionysius the Pseudo-Areopagite [soo'-doh air-ee-ahp'-uh-jyt] Dionysius the Pseudo-Areopagite is the name given to the author of certain mystical theological writings composed *c.*500. In the Middle Ages he was mistakenly identified as Dionysius the Areopagite, a man mentioned in Acts 17:34. His writings, which apply Neoplatonism to Christianity, were particularly influential in the development of scholasticism, medieval mysticism, and beliefs about angels.

Dionysius the Younger, Tyrant of Syracuse
Dionysius the Younger, Tyrant of SYRACUSE in Sicily from 367 to 344 BC, was the son and successor of DIONYSIUS THE ELDER. The regent DION OF SYRACUSE invited PLATO to Sicily in order to instruct the young Dionysius. The experiment was a failure: Dionysius was a weak and ineffectual ruler. He exiled Dion in 366, but the latter returned and seized power in 357. Dionysius was restored after Dion's murder (354) but was finally driven out by the Corinthian general TIMOLEON.

Dionysus [dy-uh-ny'-suhs] Dionysus was the ancient Greek god of fertility, ritual dance, and mysticism. He also supposedly invented wine making and was considered the patron of poetry, song, and drama.

In Orphic legend Dionysus was the son of ZEUS and PERSEPHONE; in other legends, of Zeus and SEMELE. Among the 12 gods on Mount Olympus, he was depicted as a handsome young man often carried in a leopard-drawn chariot.

One legend maintained that Dionysus died at the hands of the TITANS, who tore him apart, roasted the pieces, and began to eat them. At that point Zeus intervened, saved some of the pieces, and had Apollo bury them at DELPHI. There, it was believed, Dionysus arose from the dead each year and reigned during the three winter months, while Apollo was away.

The Dionysian festivities were often orgiastic; worshipers were sometimes overcome with ecstasy and enthusiasm or religious fervor. Plays were also staged at these festivals.

In Rome, Dionysus was called both BACCHUS and Liber.

Diophantus [dy-oh-fan'-tuhs] Diophantus of Alexandria, a Greek mathematician who flourished during the middle of the 3d century, is best known for his *Arithmetica,* a work on the theory of numbers. The *Arithmetica* is a collection of problems giving numerical solutions of determinate equations (those with a unique solution) and indeterminate equations. The method for solving the latter is now known as Diophantine analysis.

Dior, Christian [dee-ohr'] Christian Dior, b. Jan. 21, 1905, d. Oct. 24, 1957, was a French fashion designer whose post–World War II "New Look" concept (1947) brought fashion dominance back to Paris (see FASHION DESIGN). Dior became a designer for Lucien Lelong in 1942 and opened his own couture house in 1947. The New Look was a romantic approach, achieved with lengthened skirts with extra petticoats for fullness, unpadded shoulders, narrowed waists, and padded hips. After Dior's death, the House of Dior was continued by former apprentices, initially by Yves Saint-Laurent (1957–60) and subsequently by Marc Bohan.

diorite [dy'-uh-ryt] Diorite is a plutonic IGNEOUS ROCK composed of coarse grains of plagioclase FELDSPAR and less than 40 percent hornblende (see AMPHIBOLE) and biotite (see MICA), or, more rarely, PYROXENE. Small amounts of orthoclase and quartz may also occur, along with traces of magnetite, apatite, and sphene. Diorite is the plutonic equivalent of the volcanic rock ANDESITE.

Dioscorides, Pedanius [dy-uhs-kohr'-i-deez pe-day'-nee-uhs] Pedanius Dioscorides, b. AD *c.*20, d. AD 70, a Greek physician, wrote the oldest surviving text on drugs and their uses, *De Materia medica.* In this treatise of five books, which was used until the late Renaissance, Dioscorides described drugs of plant, animal, and mineral origin and gave information on drug dosage, administration, and specific uses.

dioxin The group of organic chemicals called dioxins are accidental by-products created in the process of manufacturing certain herbicides, bactericides, wood preservatives, and other products. A member of the dioxin group, tetrachlorodibenzo-p-dioxin, or TCDD, is believed by many scientists to be the most toxic of all synthetic chemicals. TCDD was a contaminant of the defoliant Agent Orange, which was sprayed on the fields and jungles of Vietnam by U.S. forces during the Vietnam War. It also contaminates the herbicide 2,4,5-T. Although TCDD's effects on humans have not been proven definitively, it is suspected of causing miscarriages, birth defects, and serious behavioral and neurological problems.

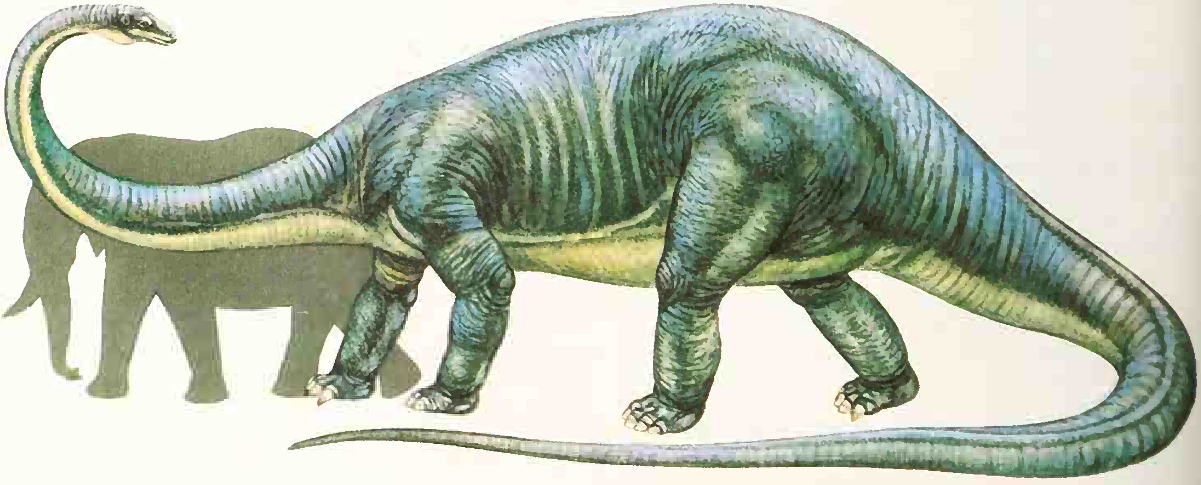
diphtheria [dif-thir'-ee-uh] Diphtheria is an acute infectious disease caused by the bacillus *Corynebacterium diphtheriae.* The bacillus infects the throat or, occasionally, the nose, skin, or wounds, producing a toxin that circulates in the bloodstream and causes most of the symptoms. The illness begins gradually with fever, sore throat, and swollen lymph nodes in the neck. A thick white membrane forms on the tonsils and may obstruct breathing and necessitate a tracheotomy, or surgical opening of the windpipe. Heart muscle and nerves may be affected, causing heart failure, paralysis, and sometimes death. Paralysis may affect speech, sight, breathing, or walking. Treatment is with antitoxin and penicillin. Infants are routinely immunized with diphtheria toxoid.

The Schick test is used to determine susceptibility to diphtheria. A small amount of dilute, purified diphtheria toxin is injected into the skin. Redness and swelling at the site on the fifth to seventh day indicate susceptibility. Absence of a reaction shows the presence of antibodies to diphtheria as a result of previous infection or immunization.

diplococcus [dip-loh-kahk'-uhs] Diplococcus is the term formerly applied to many different paired cocci of bacteria such as *Streptococcus pneumoniae,* the most common cause of lobar pneumonia. The paired cocci are spherical shaped and occur singly or in short chains. Each pair of organisms is usually pointed at the distal ends.

Diplodocus [dip-lahd'-uh-kuhs] One of the best known of all DINOSAURS, *Diplodocus* was one of the gigantic sauropods, the dominant herbivores of the Jurassic Period (see GEOLOGIC TIME). Many specimens have been collected from the Upper Jurassic Morrison Formation of Utah. *Diplodocus* had the typical sauropod build, with a large barrellike body, postlike legs, a long neck and tail, and a very small head. The name (meaning "double beam") alludes to the peculiar construction of certain tailbones, which had projections fore and aft and which

Diplodocus, despite its great length, weighed only about two or three times as much as an African elephant (the silhouette indicates scale).



protected blood vessels from friction with the ground. Although less robust (estimated live weight—10–13.6 metric tons/22,000–30,000 lb) than APATOSAURUS, it grew to a greater length—23 m (90 ft) or more. Usually thought to have been a semiaquatic animal that fed on soft water plants, it has also been pictured as a terrestrial treetop browser.

dipole [dy'-pohl] A dipole, in physics and chemistry, is a system composed of two equal and opposite electric charges, or of magnetic poles (see MAGNETISM) separated by a small distance. The molecules of certain compounds, such as water and alcohol, are permanent dipoles; although electrically neutral, each molecule maintains a separation of charge. Almost any molecule can become an induced dipole when exposed to an external field. An external electric or magnetic field exerts a torque on a dipole, aligning the particle with the field.

dipper Dippers are any of five species of songbirds, family Cinclidae, order Passeriformes, of western North America, South America, Europe, and Asia. All are aquatic, swimming and diving in rushing mountain streams. An enlarged preen gland for waterproofing the feathers, dense plumage, and a highly developed nictating membrane to protect the eyes are adaptations to aquatic habits. Their name refers to bobbing motions common to all dippers.

Diptera see FLY

Dirac, Paul [dir-ak'] The English physicist Paul Adrien Maurice Dirac, b. Aug. 8, 1902, d. Oct. 20, 1984, made significant contributions to the development of QUANTUM MECHANICS. In September 1925 he read an account of a lecture on quantum mechanics by the German physicist Werner HEISENBERG and quickly devised a number of new mathematical formulations of quantum mechanics that have since proved to be of great importance. In his first publication, in November 1925, Dirac elaborated a method for deriving the equation of motion from quantum mechanics, and a few months later he clearly defined a number of concepts that were to play a major role in the field.

Dirac's fame stems from his formulation in 1928 of a mathematical description of elementary particles that accords with both quantum mechanics and the theory of relativity. The Dirac equation was surprising in that it involved matrices (arrays of numbers that may assume different forms for different observers) rather than scalar quantities. These properties of the Dirac equation were of major importance for theoretical physics. Moreover, to everyone's astonishment, the Dirac equation provided the first rigorous description of the spin of elementary particles. Even more surprisingly, the equation had solutions for negative particle mass, from which Dirac concluded that each particle should have an anti-particle. This and other consequences of the equation were subsequently confirmed by experiment; Dirac is therefore considered to be a founder of modern quantum electrodynamics. In 1933 he was awarded the Nobel Prize for physics with Erwin SCHRÖDINGER.

Paul Dirac was awarded the 1933 Nobel Prize for physics for his modification of Schrödinger's wave equation, the mathematical theory describing the motion of atomic particles. Dirac, who shared the award with Schrödinger, applied relativity theory to quantum mechanics in predicting the existence of positrons and electron spin.

direct current see CIRCUIT, ELECTRIC

direct marketing In the field of advertising and selling called direct marketing, buyers place orders through the mail or some other nonstore channel—the telephone or a salesperson visiting the home, for example. In recent decades this type of RETAILING has been remarkably successful in the United States and Europe. Once restricted almost entirely to making customer contact through the mails, direct marketing now utilizes every advertising medium to reach its markets. The goal is always a direct response: a successful ad will persuade potential customers to return a coupon or dial a telephone number.

Contributing to the success of direct marketing have been such relatively new MARKETING methods as the use of sales forces trained in telephone selling, or "telemarketing"; the availability of toll-free telephone numbers for buyers to call; television shopping channels, which offer merchandise that viewers can order by telephone; and mass mailings to alert customers to events such as the heavily publicized sweepstakes drawings that promote sales campaigns. Most important has been the development of computer-generated mailing lists of potential customers, pinpointed as to income, interests, occupation, or any of a number of characteristics that are used to define a market.

directing In the theater, directing a play is the single most important function after the writing of the script. The director determines the interpretation; selects the cast; works with designers and technicians in preparing costumes, sets, lighting, and music; and generally takes charge of the entire production.

Role of the Director. In cooperation with the dramatist (if still living) and with the producer responsible for financing and organizing the enterprise, the director chooses the actors, scene designers, and other collaborators. The choice of actors is of paramount importance. The director must be certain that the actors suit the roles to be played, that they look and sound appropriate for the parts, and that they are compatible with the company as a whole. The director must also determine the strengths and weaknesses of performers in terms of the particular demands of the play.

The director next determines the interpretation of the play: its theme and style, the main action or conflict, how it is meant to strike—or will strike—the audience. For example, Anton Chekhov's *The Cherry Orchard* may be viewed either as tragedy or comedy; the director's interpretation determines the nature of the production.

During rehearsal, the director plans the positions and movements of the actors within a stage setting chosen in collaboration with the set designer. The director plans the movement of the actors during the play, and a good director takes the actors' aptitudes and dispositions into consideration. Because theater is a collective art, the director unifies all the elements that enter into the production of a play—by explanation, suggestion, demonstration, and sometimes by command.

History of Directing. Although plays have been directed in some sense since ancient times, directing did not become a distinct profession until about the beginning of the 20th century. Ancient drama was often directed by the author, who was also frequently an actor in the play. The practice of having an experienced actor guide other players lasted into the 19th century with the concept of the actor-manager or stage manager.

With the emergence of a separate director, the actor-manager became obsolete, although a few actor-directors are still active today. The term *stage manager* now applies to an assistant to the director, one who is largely responsible for the physical staging. In turn, the role of the director has been greatly expanded. With the increasing complexity of 20th-century theater, the director must coordinate teams of specialists, each with its own coordinator. The director's task is so demanding that two or more codirectors may be required, particularly with the technical complexities of radio, television, film, and musical theater.

See also: ACTING; IMPROVISATIONAL AND EXPERIMENTAL THEATER; STAGE LIGHTING; THEATER, HISTORY OF THE; THEATER ARCHITECTURE AND STAGING.

Directoire style The Directoire style of decorative arts separated the Louis XVI and Empire periods and reached its peak during the period of the DIRECTORY (1795–99) in France. The style was characterized by simple, unornamented forms often based on classical models. The austerity of the style reflected the economic necessities of a country impoverished by revolution and war—the costly materials used during the Louis XVI period for gilt-bronze furniture mounts, veneers, and marquetry designs could not be financed or imported from abroad. New decorative motifs, inspired by political and military events, included the classical palmette, lozenge, serpent, swan, and sphinx, and such patriotic emblems of the Revolution as Phrygian bonnets and trees of liberty.

Directory In French history, the Directory was the group of five men that constituted the governmental executive from 1795 to 1799. The directors were chosen by the legislature, which consisted of the Council of Ancients and the Council of Five Hundred; one director was replaced each year.

Under the directors, the most notable of whom were Lazare Carnot (see CARNOT family) and the Vicomte de BARRAS, France enjoyed great military and diplomatic success until 1797. Thereafter, corruption and military defeats made the Directory increasingly unpopular. It was overthrown by Napoléon Bonaparte (see NAPOLEON I) in the coup d'état of 18 Brumaire (Nov. 9, 1799) and replaced by the CONSULATE. (See also FRENCH REVOLUTION.)

dirigible see AIRSHIP

Dirks, Rudolph Rudolph Dirks, b. Feb. 26, 1877, d. Apr. 20, 1968, was a German-born cartoonist and painter, best known for his COMIC STRIP creation "The Katzenjammer Kids." He began the color cartoon in 1897, basing it on the German strip "Max und Moritz." It follows the mischievous adventures of the brothers Hans and Fritz, whose fractured German dialogue appears in balloons. Because of anti-German sentiments, Dirks later retitled the strip "The Captain and the Kids." The strips first appeared in the *New York Journal* (1906–07) and were later collected in *The Katzenjammer Kids* (1974).

Dirksen, Everett M. Everett McKinley Dirksen, b. Jan. 4, 1896, d. Sept. 7, 1969, was the Republican leader of the U.S. Senate from 1959 to 1969. Born and reared in Pekin, Ill., he practiced law there and served in the U.S. House of Representatives from 1933 to 1949. He was elected to the Senate in 1950. There, his colorful personality and conservatism endeared him to his fellow Republicans, who named him party whip in 1957 and minority leader in 1959. Despite his conservatism, Dirksen supported Lyndon B. Johnson's civil rights legislation of the 1960s; his endorsement was crucial to its final enactment. He also supported the nuclear-test-ban treaty of 1963.

Disabled American Veterans Disabled American Veterans is an organization of veterans with war-related disabilities. It was founded in 1921 by Judge Robert S. Marx and a committee of veterans injured during World War I to provide assistance to disabled veterans and their dependents. Headquartered in Cold Spring, Ky., it maintains representatives in each regional Veterans Affairs office to help members obtain VA benefits.

disabled persons see HANDICAPPED PERSONS; REHABILITATION MEDICINE

disarmament Disarmament is the traditional term for the elimination (as well as the limitation or reduction) of the means by which nations wage war. During the 1960s, with the international focus on nuclear armaments and on the two competing superpowers, the USSR and the United States, the term *arms control* came into general use for the negotiated limitation of weapons and their means of delivery.

Recorded disarmament agreements reach back to antiquity in a number of cultures—Chinese, Mesopotamian, Indian, Greek, and Roman. In modern history, disarmament negotiations were significant in the 19th century, and in the 20th century they have assumed a crucial place in diplomacy.

Modern Disarmament Efforts. In 1817, in the Rush-Bagot Treaty, the United States and Britain limited the number of their ships on the Great Lakes. This agreement, an example of reciprocal "local disarmament," has also been maintained in spirit along the long, unfortified U.S.-Canadian land boundary for many decades. The international HAGUE CONFERENCES of 1899 and 1907, called by Tsar Nicholas II of Russia, failed to achieve their main objective of reducing armaments, in large part because of German objections.

U.S. president Woodrow Wilson's FOURTEEN POINTS peace program, issued in 1918 before the end of World War I, asked that "national armaments be reduced to the lowest point consistent with domestic safety." Wilson's program was modified at the Paris Peace Conference (1919–20), but the 14th point gave birth to the LEAGUE OF NATIONS, a peace-promoting organization with a chief aim of fostering disarmament.

The WASHINGTON CONFERENCE (1921–22), with Britain, France, Italy, Japan, and the United States as participants, attempted to achieve naval disarmament by limiting the number of warships the signatories could have. At the London Naval Conference of 1930 (see LONDON, TREATIES AND CONFERENCES OF) the same signatories agreed to a ratio of naval strength covering a broader range of naval weapons. This agreement held only until 1936.

The World Disarmament Conference (1932–37) in Geneva (see GENEVA CONFERENCES) was sponsored by the League of Nations. For years the League had been considering, among other security and disarmament problems, those stemming from the arms limitations that the victorious World War I Allies had imposed on the defeated Central Powers. The meeting, at Britain's suggestion, took up questions of "qualitative disarmament." There was substantial agreement on these questions, involving essentially distinguishing between defensive and offensive arms. Late in 1933, however, Germany, now led by Adolf Hitler, withdrew from the conference, which continued intermittently until 1937, ending in failure.

Post–World War II Developments. The Allies oversaw the disarmament of Japan and Germany after World War II. The UNITED NATIONS (UN) took up the League's mission of promoting disarmament; in 1952 the UN Disarmament Commission, established by the UN General Assembly, began its work. Important UN-sponsored treaties in disarmament and arms control include demilitarizing outer space (1967), prohibiting the spread of nuclear weapons (1968) and the placing of such weapons on the ocean floors (1971), and banning biochemical (1975) and environmental (1976) warfare. (For a discussion of U.S.-Soviet arms negotiations, see ARMS CONTROL.)

Public protests and political pressure have played a role in the arena of nuclear disarmament. Groups in many countries, fearing that nuclear arms could lead to devastating destruction or even the extinction of life, have taken a variety of stands. These range from advocating a nuclear freeze—maintaining nuclear arsenals at current levels and ending further testing and deployment—to removing nuclear weapons from national territory, to unilateral (one-sided) disarmament. Calls for nuclear-free zones in various regions have been widespread: the leaders of New Zealand and Australia (which has an active Nuclear Disarmament party) called for one in the South Pacific; the president of Brazil, for one in the South Atlantic; and political activists in Germany, for such a zone in central Europe. Political and military leaders have had to take account of these political developments in their defense planning and diplomacy.

discharge, electrical Electrical discharge is any form of loss of electrical charge (see ELECTROSTATICS). Rapid discharges through a gaseous medium result in luminous displays as atoms or molecules of the gas are ionized. The most dramatic example of an electrical discharge in nature is LIGHTNING, a form of arc discharge (see ARC, ELECTRIC).

Corona discharges such as SAINT ELMO'S FIRE are natural phenomena involving lower currents. As in various gas-discharge tubes, dark regions occur, and the gas emits a diffuse glow. This phenomenon is called glow discharge. A spark discharge may be thought of as a transitional phenomenon between a glow discharge and an arc discharge.

disciple see APOSTLE

Disciples of Christ The Disciples of Christ, or Christian Church, is part of the largest religious movement to have originated in the United States. The church had its beginnings in Kentucky and western Pennsylvania in 1804–09. Kentucky Presbyterian minister Barton W. STONE and others who shared his liberal views on pulpit freedom and on associations across denominational lines withdrew from the Presbyterians to become "Christian only." Pennsylvanian Thomas Campbell split with the Presbyterians over his right to serve the Lord's Supper to Christians of different persuasions. The two groups united in 1832 as Campbell's son Alexander CAMPBELL became the prominent figure in the movement.

In the 20th century there have been two separations: the CHURCHES OF CHRIST objected to musical instruments in worship and officially withdrew in 1906; the North American Christian Convention, another conservative faction, pulled away gradually between 1926 and 1969 and became known as the CHRISTIAN CHURCHES AND CHURCHES OF CHRIST.

Due to their origin as a protest against denominational exclusiveness, the Disciples are characterized by a commitment to interdenominational activity, autonomy in its levels of polity, and general liberality. They claim to have no official doctrine; membership ordinarily requires only a confession of belief in Jesus Christ and subsequent baptism by immersion of its adult believers. The custom is to have the Lord's Supper central to every worship service and to have lay people regularly preside.

disco music see ROCK MUSIC

discount rate A discount rate is an INTEREST rate charged by a CENTRAL BANK, for example, the Federal Reserve System in the United States, on loans to other banks. By raising or lowering the discount rate, the central bank can influence interest rates throughout the banking system. A higher interest rate tends to discourage borrowing, thus decreasing the supply of money available to the public; a lower discount rate has the opposite effect.

Discoverer *Discoverer* was the name given to a series of 38 satellites launched—26 successfully—between February 1959 and February 1962. The series was used by the U.S. Air Force to test designs and techniques applicable to future military space systems. *Discoverer 1* was the first satellite of any country to be placed into a polar orbit and the first designed to be recovered from orbit.

discriminant [dis-krim'-ih-nent] A discriminant is a relatively simple expression constructed from the coefficients, or constant factors, of a POLYNOMIAL equation. The discriminant can be used to determine some of the properties of the equation, such as the nature of the ROOTS or the graph of the equation. The simplest case is the quadratic equation (see QUADRATIC FUNCTION) in the standard form $ax^2 + bx + c = 0$. The coefficients in this equation are a, b, and c, and the discriminant is $b^2 - 4ac$. If the discriminant is positive, two real roots exist. If it is a perfect square, the roots are rational. If it is zero, one distinct root (or two equal roots) exists. If it is negative, the roots are the pair of imaginary numbers $a + bi$ and $a - bi$.

discrimination Discrimination, in society, can be defined as the unequal treatment of equals. Another way of putting it is to say that a person is denied EQUAL OPPORTUNITY for reasons that are not relevant to the task at hand. Discrimination may be experienced by ETHNIC MINORITIES or religious minorities (see ANTI-SEMITISM). Occasionally, as in South Africa, the majority group is the target of discrimination (see APARTHEID). Discrimination may also be directed at women, old people, HANDICAPPED PERSONS, and homosexuals.

There is a distinction between discrimination and prejudice. Discrimination is expressed in overt, concrete behavior, while prejudice is expressed in attitude. It is usually assumed that the person who discriminates does so because of prejudice, but this is not the case when a personnel manager refuses to hire young people strictly because of company policy.

Efforts to combat racial discrimination and RACISM have figured prominently in the post–World War II history of the United States. The CIVIL RIGHTS movement of the 1950s and '60s won the passage of important legislation such as the CIVIL RIGHTS ACTS and VOTING RIGHTS ACT. Progress toward INTEGRATION among blacks and whites has been especially dramatic in the South. AFFIRMATIVE ACTION was designed to help correct past patterns of discrimination in employment.

After U.S. women won the right to vote (see SUFFRAGE, WOMEN'S), in 1920, they still had much to do to combat sexist discrimination in educational institutions, employment, and the law (see FEMINISM; SEXISM). Although the EQUAL RIGHTS AMENDMENT failed to win ratification, federal and state legislative measures prohibit various discriminatory practices against women (see also WOMEN IN SOCIETY).

Recent years have seen an increased concern with discrimination against older people. Political lobbying by organizations representing the elderly and their interests has brought changes in laws and ordinances relating to senior citizens. Homosexuals, for their part, have successfully promoted the passage of civil rights protection for the gay community in many places, although the AIDS crisis that developed in the 1980s fueled additional antigay prejudice and discrimination. A bill protecting the rights of the disabled, including those with AIDS, became federal law in 1990.

discus see TRACK AND FIELD

Disdéri, André Adolphe Eugène [dees-day-ree'] French photographer André Adolphe Eugène Disdéri, b. 1819, d. *c.*1890, won fame and a vast fortune by mass-producing carte de visite photographic portraits. In 1854 he patented the technique for making these small (101.6 mm × 63.5 mm/4 in × 2½ in) portraits. They became immensely popular and had replaced the DAGUERREOTYPE by 1859, when Disdéri became court photographer. Cartes de visite were so inexpensive that anyone could afford a portrait, and many collected portraits of the famous. Disdéri squandered his fortune and died in a poorhouse.

disease A disease is any condition that disturbs the normal functioning of a living organism, whether in whole or in separate organs or systems. The term may also be defined as the failure of an organism to respond adaptively to its environment. The word *disease* itself simply means "dis-ease," that is, lack of health and well-being. Diseases are usually distinguished from injuries, which are physical disruptions of an organism. In addition, the term usually does not include basic AGING processes, although a number of degenerative conditions associated with aging are also considered diseases.

The concept of diseases has changed over historical time. Early peoples tended to view them only as divine interventions, until individuals such as HIPPOCRATES learned to deal with them as natural processes as well. Before the development of the CELL theory and the advent of modern medical science, however, only the gross changes resulting from diseases were recognized as symptoms. The microbiological aspects of disease were not understood until recent times.

All organisms, from the simplest to the most complex, are subject to diseases. Those affecting human beings number in the thousands. The causes of some diseases remain unidentified, while recognized causes range from living or nonliving agents that invade or otherwise affect the body, to various environmental and psychological conditions, to hereditary factors. Because of this diversity, diseases may be grouped in a number of different ways. This encyclopedia provides articles under several such groupings: by type of cause (for example, GENETIC DISEASES; INFECTIOUS DISEASES; PROTOZOAL DISEASES); by system or organ concerned (BONE DISEASES; EYE DISEASES; NERVOUS SYSTEM, DISEASES OF THE; UROGENITAL DISEASES); by environmental factors (DISEASES, OCCUPATIONAL; NOSOCOMIAL DISEASES); by age group; and so on. Numerous entries on individual diseases also appear, as well as articles on a wide range of animal diseases, individually and by groups.

See also: DISEASES, PLANT.

diseases, animal Animal diseases are as numerous and varied as the diseases that afflict human beings, but except for the diseases that are observed in the species most closely associated with humans they are generally less well known or understood. Besides their effects on the animals themselves, such diseases are of concern for the ecological imbalances that may occur when large animal populations or species that form crucial links in the food chain are significantly reduced in number by disease. Some animal diseases, called ZOONOSES, are also transmissible from animals to humans, and they may require rigorous control programs to check their spread. Humans are often affected economically by animal diseases that involve species important in ANIMAL HUSBANDRY, and diseases that afflict pets are of course also a focus of human interest. The study, prevention, and treatment of diseases in both domesticated and wild animals is called VETERINARY MEDICINE.

The fact that some animal diseases are transmissible to humans was demonstrated in 1796, when Edward JENNER, a British physician, discovered that milkmaids who had been infected with COWPOX, a localized skin eruption in cows and humans, were protected against SMALLPOX. This showed that animal viral diseases also afflict humans. More than 100 such zoonoses are now known to be transmitted from animals to humans, and three-fourths of the rural human population of the world suffers from animal diseases. Rabies alone causes the death of several thousand people each year, and about 10 percent of the world's animals suffer from tuberculosis. In many parts of the world the soil is heavily contaminated with spores of anthrax, a disease that is spread from domestic livestock to humans. Among the many other zoonoses are brucellosis, bubonic plague, influenza, leishmaniasis, psittacosis, salmonellosis, toxoplasmosis, and tularemia.

Infectious Diseases

Animals fall prey to both infectious and noninfectious diseases. Infectious diseases are caused by agents that invade the host. They include viruses, bacteria, rickettsial organisms, chlamydial organisms, fungi, and mycoplasmal agents, as well as internal and external parasites.

In establishing infection, most organisms bypass primary defenses such as the skin. The organisms may enter through breaks in the skin, such as abrasions, cuts, or insect bites. At other times they enter through the body orifices. Contamination of premises and equipment results from the release of infected discharges, so it is essential to isolate infected animals.

Once in the body, infectious agents may cause a rise in temperature and an increase in pulse and respiration rates. Local or generalized infection may ensue. Animals in the early stages of disease may show no evidence of infection. As the infection progresses, however, the animals may stop eating and producing. Other signs may also be evident, though only a competent veterinarian can make a reliable diagnosis.

Slow-Virus Diseases. Slow-virus diseases include scrapie, a nervous disorder of sheep and goats. This is an infection imposed by a polypeptide (a part of a protein) closely associated with a deoxyribonucleic acid (DNA) molecule, which together may be considered a partial virus or viruslike agent (see VIRUS, SLOW). Reported in many parts of the world, scrapie produces an intense, progressive itching along with a lack of coordination and finally an inability to walk. Scrapie develops slowly and may last months or years before it is fatal. Although contact exposure appears sufficient to transmit the agent, breeding is perhaps the most common means of transfer. No treatment is known for scrapie.

Viral Diseases. True viruses produce many of the most common human and animal diseases. RABIES, or hydrophobia, is caused by a *Rhabdo* virus. This disease is characterized by nerve irritability, brain damage, inability to move, and, finally, death. It is transmitted primarily by the bite of an infected carnivorous animal and has been reported in virtually all animals and birds. Rabies has largely been controlled in certain places, including the United States; worldwide, however, it is a serious problem. Vaccination is important, to prevent the development of the disease.

Pox is a febrile (fever-producing), worldwide, infectious skin disease of animals, birds, and humans. Wartlike growths appear on the skin and on lining membranes of the mouth and throat. Any break in the skin or membranes may permit the entrance of the viruses. Insects may transmit pox viruses as they penetrate skin tissues. Specific pox vaccines are available for controlling and preventing infection.

Rinderpest, or cattle plague, is a serious febrile *Paramyxo* virus related to the distemper virus of dogs. It affects cattle and buffalo as an erosive disease of the mouth, stomach, and intestines. The disease is common in Asia and Africa but is not established in North America. Infection spreads by inhalation and by direct and indirect contact. The disease may be controlled by vaccination in cases where animals are not isolated or slaughtered.

FOOT-AND-MOUTH DISEASE is a highly contagious, febrile viral disease chiefly of cloven-hoofed animals. It is transmitted by both direct and indirect contact with contaminated discharges. Although it appears throughout the world, the disease has not gained a foothold in the United States (the last outbreak occurred in 1932), Canada, Great Britain, Australia, or New Zealand. The greatest meat, milk, and productivity loss results from debility and an inability to eat properly. Blisters, or fluid-filled vesicles, appear in the mouth and nostrils and on the feet and teats. Because the virus, *Picorna*, occurs in several types and subtypes, specific vaccines must be used.

Canine distemper is a highly contagious, febrile, *Paramyxo* virus disease of dogs. Feline distemper, caused by a different virus, affects foxes, mink, skunks, raccoons, and other species. Distemper is transmitted primarily by nose or eye discharges. It appears later as a respiratory disease and, in uncontrolled cases, involves the nervous system. Young animals and unvaccinated pets often die even with treatment.

PARVOVIRUS is best known as an infectious disease of dogs, although other parvoviruses afflict cattle, pigs, and humans. Also known as canine parvoviral enteritis, it infects the gastrointestinal tract and is often fatal unless treated. A vaccine is available; yearly booster shots are recommended.

Infectious HEPATITIS of dogs is a highly contagious, febrile *Adeno* virus disease that occurs worldwide. If not arrested, the disease first takes the form of a liver disorder and later becomes a brain infection. In some dogs it is a respiratory disorder. Infectious hepatitis is transmitted by the discharges of the infected animal, and contaminated urine is often the source of infection. The disease prolongs bleeding time and decreases white-blood-cell count. A common symptom is opaqueness of the cornea. Yearly vaccinations are usually advisable.

Bacterial Diseases. LEPTOSPIROSIS is an acute or chronic bacterial disease found worldwide in many animals, including cattle, hogs, dogs, rats, and humans. It is caused by *Leptospira* organisms transmitted via contaminated food or water. It is characterized by anemia, degeneration of the liver and kidneys, jaundice, and abortion. The main symptoms in humans are fever, muscle pain, and conjunctivitis.

TUBERCULOSIS is a chronic, infectious bacterial disease of ancient origin, affecting humans and numerous animals. It is caused by *Mycobacterium tuberculosis* of the human, bovine, or avian type. Tuberculosis is transmitted by ingestion, inhalation, or wound infection and is characterized by a persistent invasion of tissues, loss of flesh, and eventual death.

ANTHRAX is a bacterial disease that afflicts sheep, goats, cattle, horses, and humans throughout the world. Animals may die without any indication of trouble before death. The organism may be ingested through contaminated feed or water, or it may be inhaled. Even biting insects may instill the spores, which develop whenever the organism is exposed to air. Infected animal products have been found to cause outbreaks. Grazing animals usually get anthrax in infected pastures; most cases are fatal. Common symptoms in animals include high fever and bleeding from body openings. A chronic localized form may occur in dogs and swine. Entering the upper respiratory tract, anthrax results in severe edema of the head and neck and usually results in death.

BRUCELLOSIS is a worldwide bacterial reproductive disease of animals and humans; it is caused by four species in the genus *Brucella B.* Animals transmit it by ingestion and infrequently by copulation. In humans it produces undulant fever. In cattle infected by *B. abortus,* it is characterized by retained placenta, weak young, difficult breeding, infertility, and abortion. Swine often have arthritis and enlarged testes, and horses may have an abscess at the withers.

Salmonellosis, caused by the same bacteria that cause SALMONELLA food poisoning in humans, is among the major diseases of both wild and domestic mammals and birds. In swine, for example, *Salmonella cholerasuis* has resulted in extensive losses of pigs, particularly when it has been found in conjunction with hog CHOLERA virus. It causes intestinal ulcers and diarrhea.

Rickettsial Diseases. Q FEVER is a rickettsial disease of cattle, sheep, and goats and an acute respiratory disease of humans. It is caused by *Coxiella burneti* and is transmitted by inhalation, tick bites, contaminated milk, and direct and indirect contact with infected animals and their excretions. It has been reported widely in Europe as well as in Australia and North America. A vaccine has been developed for anaplasmosis, a common rickettsial disease of cattle.

Chlamydial Diseases. PSITTACOSIS is an acute or chronic respiratory and systemic disease of wild and domestic birds, which may be transmitted to animals and humans. It is caused by *Chlamydia psittaci.* Mammalian strains may cause reproductive and arthritic problems. Psittacine birds are often infected.

Fungal Diseases. Fungal diseases include such diseases as aspergillosis (see ASPERGILLUS) and RINGWORM. The latter is an infectious skin disease of animals, whereas the former is a respiratory tract infection of birds. *Candida albicans* is a yeastlike fungus commonly found in the digestive tract of animals and birds. It may be either a serious disease-producing organism or a secondary invader, and it may cause thrush in human infants.

Mycoplasma Diseases. Mycoplasma agents usually cause respiratory infection, but they may also produce generalized systemic infections. Contagious pleuropneumonia of cattle and chronic respiratory disease of chickens are examples.

Parasitic Diseases. Parasitic diseases are classified as internal and external. Internal parasites include TAPEWORMS and flukes; roundworms such as intestinal HOOKWORMS and roundworms of the heart, lung, stomach, kidney, eye, trachea, muscle, and blood vessels; thorn-headed worms; and protozoans such as coccidia, toxoplasma (see TOXOPLASMOSIS), sarcocystis, trypanosomes (see TRYPANOSOMIASIS), leishmania (see LEISHMANIASIS), trichomonads (see TRICHOMONIASIS), amoebas, and blood organisms, including malarial. External parasites include bots, ticks, mites, lice, fleas, gnats, flies, mosquitoes, and bedbugs.

Parasitic diseases may be extremely debilitating. Skin mites are tiny blood-sucking creatures that cause serious skin problems. Coccidiosis afflicts the intestinal tract with cellular destruction and in some cases causes severe loss of blood. Roundworms, depending on the type, produce mild to serious problems. Hookworms suck blood from the intestinal tract. Flukes, or flatworms, can produce serious and often fatal problems in humans and animals.

Noninfectious Diseases

Noninfectious diseases are perhaps far more common than infectious problems.

Nutritional illnesses occur often in spite of the wealth of information available concerning standard dietary levels for each species. Metabolic disorders, such as milk fever of cattle or pullet disease of chickens, result from a disturbance in the body chemistry, which may be caused by stress.

Burns may be chemical or thermal and result from mismanagement in most instances. Cysts and tumors occur in various parts of the body. These represent excessive new growths of specific tissues that persist with or without original stimuli.

Pathological conditions include such diseases as abscesses, edema, and emphysema, all of which involve changes in physiology and underlying function. Anatomical diseases are those in which a change in anatomical structure and associated function is evident. This includes bloat, which develops when the release of stomach or intestinal gas is interfered with. Fractures or broken bones are similarly classified.

See also: cat; DOG; HORSE; PIG; articles on other animals.

diseases, childhood Children are prone to many if not most of the diseases of adult human beings, except for those related to developmental and aging processes. Certain infections, however, usually occur during childhood because of their contagious nature. Many are upper RESPIRATORY TRACT DISORDERS, so the initial symptoms of fever, malaise, headache, and—often—chills tend to be similar to those of the common cold.

Among the most common diseases of childhood are the VIRUS infections CHICKEN POX (varicella), GERMAN MEASLES (rubella), MEASLES (rubeola), MUMPS (parotitis), and—on a worldwide basis—POLIOMYELITIS. Common bacterial diseases include DIPHTHERIA, SCARLET FEVER, and WHOOPING COUGH (pertussis). Bacterial infections are also a hazard to children whose immunity has been reduced by other diseases or by immunosuppressive therapy (see INFECTIOUS DISEASES). Among the many complications possible with childhood diseases are MENINGITIS, PNEUMONIA, otitis media (inner EAR DISEASE), and SINUSITIS. Central nervous system damage, including REYE'S SYNDROME, can result from viral infections.

Worldwide, respiratory diseases are the leading cause of childhood deaths. Such diseases include pneumonia, measles-related infections, and whooping cough. The leading single cause of death by disease, however, is DIARRHEA, which is the biggest killer of infants in developing countries. Another major cause of death is TETANUS. Most childhood diseases are now preventable with vaccines (see VACCINATION), and one major scourge, SMALLPOX, has been eliminated worldwide. In general, however, developing regions continue to show high fatality rates because of inadequate health-care services, poorer nutrition and sanitation, and generally lower levels of health (see NUTRITIONAL-DEFICIENCY DISEASES).

See also: FIFTH DISEASE; GENETIC DISEASES; KAWASAKI DISEASE.

diseases, occupational Diseases that result from exposure to poisonous chemicals, radiation, noise, and other hazards of the workplace are classed as occupational diseases. Together, they are a major cause of illness and death in modern industrial countries. In newly industrializing countries, which lack regulation and experience, working conditions are often highly hazardous.

Work-caused disease is an ancient problem. The link between lung diseases and mining, for example, has been known for centuries. By the time of the Industrial Revolution, many other occupational diseases were recognized. Occupational CANCER was first observed in English chimney sweeps; it was presumably caused by soot, which contains many carcinogens (cancer-causing substances). MERCURY poisoning was common among hatters, who used mercuric nitrate in the preparation of felt. Pottery workers suffered from SILICOSIS, a lung disease caused by exposure to the silica dust in clay. LEAD used in pottery glazes caused lead poisoning.

Occupational disease became a subject of medical study in 19th-century Europe. By 1900 a few doctors in the United States began work on the problem. Prominent among them was Dr. Alice HAMILTON, who studied lead poisoning among factory workers in Chicago and found 77 different occupations where lead poisoning was an occupational hazard.

Types of Occupational Diseases

The principal categories of occupational disease are those diseases caused by biological and physical hazards, by a variety of dusts and other particulates produced in manufacturing and mining, and by many of the chemicals used to produce such relatively new products as plastics and computer chips. The disease problem is compounded by the phenomenon known as synergism, where the toxicity of a substance in the body is increased when other toxic substances are also present. An asbestos worker, for example, is far more likely to contract lung cancer if he or she is also a cigarette smoker.

Biological Hazards. Exposure to infectious diseases such as hepatitis B and, less frequently, AIDS is common among hospital workers. Agricultural workers are subject to many diseases transmitted by animals; for example, workers handling wool and hides may be exposed to the often fatal bacterial disease ANTHRAX. Long-term occupational exposure to plants and plant products sometimes induces allergic responses, including asthma and hay fever (see ALLERGY).

Physical Hazards. Noise, radiation, heat, cold, and low-frequency vibrations are all physical hazards of the workplace. Noise, which may cause permanent deafness and stress-related conditions such as high blood pressure, was until recently the most prevalent industrial hazard. In the late 1980s, however, it was replaced by repetitive stress injury (RSI), a consequence of repeated motion (see CARPAL TUNNEL SYNDROME). The main symptoms include severe pain in the hands or arms and sometimes a partial loss of function.

Radiation-induced cancers first attracted public notice during the 1920s, when workers whose job it was to paint luminous radium on watch dials contracted bone cancer. The wide use of radioactive substances since World War II is considered a reason for the increase in the number of cancer cases, particularly among workers in nuclear power and nuclear weapons plants (see NUCLEAR REACTOR), and in shipyards where nuclear-powered vessels are built.

Radiation problems have also been associated with computer monitors (video display terminals, or VDTs). There is some evidence that VDT radiation may cause reproductive as well as other physical problems. Other complaints may be caused by a combination of eyestrain and the stress associated with high-speed typing, an activity that also produces RSI.

Dust Diseases. Among the most common occupationally induced diseases are those associated with dust: miners' diseases, including BLACK LUNG; silicosis; byssinosis, or brown lung, caused by cotton dust; various metal-dust diseases; and the diseases caused by ASBESTOS—asbestosis, a severe lung impairment, and the cancer mesothelioma.

Chemical Hazards. Thousands of chemical substances are in commercial use, and almost all present some hazard. Perhaps one in ten causes cancer. (Although the number of proven carcinogens is small, most chemicals have not yet been adequately tested for carcinogenicity.)

The hazards associated with the chemical class known as halogenated hydrocarbons are typical of many other chemical substances. The halogenated hydrocarbons used in the manufacture of pesticides, herbicides, industrial solvents, refrigerants, and plastics are known to cause damage to the liver, nervous system, skin, and sometimes other organs; many of them cause cancer. Generally workers are exposed to much higher concentrations than the general public and are therefore much more at risk. Standards regulating exposure levels have been set for some of these substances but not for others.

Occupationally Induced Cancers. An estimated 20 percent of all cancer in the United States is caused by occupational exposure. Cancers may take decades after exposure to develop, and documentation of the cause is often difficult. About 1,500 substances are suspected of causing cancer; for a few hundred, such as BENZENE, the proof is considered strong.

Reproductive Hazards. Workplace hazards presented to human reproductive systems have become a central issue, especially since employers, rather than removing the hazards, have instead attempted to deny women potentially hazardous jobs. Men are also reproductively at risk, although this fact has yet to be widely recognized.

Present U.S. Laws

The 1971 Occupational Safety and Health Act established the National Institute of Occupational Safety and Health (NIOSH), which was to do the research necessary to establish basic industrial health and safety standards. The act also established the OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA) within the U.S. Department of Labor and empowered OSHA to write and enforce the regulations based on those standards. The Department of Health and Human Services also has responsibilities under the act.

See also: POLLUTANTS, CHEMICAL; WORKERS' COMPENSATION.

diseases, plant

diseases, plant Ever since humans began to cultivate PLANTS as crops, they have been troubled with plant diseases. Early civilizations regarded plant diseases as a manifestation of godly displeasure. Not until the beginning of the 19th century was the nature of plant disease established scientifically. Even this discovery, however, did not avert some disastrous outbreaks of disease. In the mid-1840s famine struck Ireland when the potato crop was destroyed by a fungus. From 1845 to 1860, 1 million people died from this famine, and 1.5 million emigrated. Nearly a century later (1942–43), another fungus, brown spot disease, *Helminhosporium oryzae*, ravaged the rice crop in Bengal; some 2 million people died of starvation. Even in those countries with economic and social structures that preclude famine, the losses caused by plant disease are considerable.

Pathogens

The living agents, such as bacteria, that cause plant disease are called pathogens. No generally accepted term has been found to describe nonliving, disease-causing agents, which include mineral excess or deficiency, atmospheric pollutants (such as sulfur dioxide), pesticide overdosage, or faulty herbicides. These are variously called nonparasitic agents, abiotic factors, or pathogens.

Most plant pathologists, however, restrict the use of the term *pathogen* to living agents.

The pathogens may be divided into seven groups: BACTERIA; FUNGI; VIRUSES; mycoplasmas and related microorganisms; NEMATODES; some other animals, such as insects and mites; and a few flowering plants, such as dodder (genus *Cuscuta*), broomrape (*Orobanche*), and WITCHWEED (*Striga*). The plants that support pathogen activity are called hosts, and the sequence of events in disease development, beginning with the initial contact between a pathogen and its host, is called pathogenesis. Not all pathogens live exclusively on their hosts. Some can use dead organic material for food as well.

Symptoms

Disease results from the interaction of a pathogen with its host, although the intensity and extent of this interaction are affected markedly by environmental factors such as temperature, rainfall, humidity, light, soil fertility, and pH. In any diseased plant, symptoms indicate the nature and extent of the pathogen-host interaction. The main types of symptoms are: (1) death of the tissues, or necrosis, especially on leaves, where the localized areas of diseased tissue (lesions) generally assume characteristic shapes; (2) an abnormal increase in the size or number of the host's cells, which leads to an abnormal abundance of shoots (witches'-broom), swollen roots (clubroot), abnormal protuberances (galls), or localized callus formation around dead areas on trees (CANKERS), fruits, or long-lived organs such as tubers (scab); (3) a failure to attain normal size or development; (4) a change in color, such as the leaves turning yellow (chlorosis) or developing red pigments (anthocyanescence); (5) wilting, which usually indicates an invasive interference with the normal movement of water within the plant; (6) disintegration of the tissues by bacteria or fungi, often accompanied by a release of fluids from the plant cells (wet rot) or sometimes by a drying out of the cells to produce a powdery mass (dry rot); and (7) excessive gum formation (gummosis).

In many fungal diseases, the appearance of the spore-bearing organs of the pathogens is a certain guide to the nature of the disease. These visible growths are often called the signs of the disease to distinguish them from the symptoms.

Pathogenesis

Pathogens show great diversity in the ways they perennate (survive from season to season), in the types of inoculum (infective particle) they produce, in the way these inocula are dispersed, and in the range of plants they infect.

Systemic Infection. A typical route of pathogenesis is that of late blight of potatoes, the disease that caused the disastrous potato famine in Ireland. The late-blight pathogen is the fungus *Phytophthora infestans*, which grows in the leaves and stems. It progressively kills the tissues and reduces the effective photosynthetic area of the plant. Consequently, little synthesized material passes to the tubers (potatoes). These stop growing, and yield is reduced. Under moist conditions, the fungus grows out from the infected tissues and can be seen as a white bloom at the edge of the lesion. The spores are dispersed by rain and initiate new infections on leaves and stems; or, when they are washed into the soil, they infect the developing tubers. Tubers also may be infected at harvesting if they contact diseased foliage that bears spores. Some infected tubers rot in storage because other microorganisms, especially bacteria, invade them through the blight lesion. Others do not rot, and if these are used to establish a new crop, a few may give rise to an infected shoot bearing a lesion with sporulating *P. infestans*. Infected tubers discarded at harvest or from storage may also be a similar source of spores that initiate infections on adjacent young potato crops. Thus, two distinct phases occur during the cycle of *P. infestans:* an active colonization (infection) of the growing plant that involves some agent (in this instance, rain) to distribute its infective particle, or spores; and a less active period between crops, spent in infected tubers.

Many pathogens of annual crops survive in association with their hosts because they infect the planting material or seed. Pathogens on woody perennials often survive in localized areas of diseased tissue, such as cankers or galls.

Other pathogens survive in the host's buds. One example, powdery MILDEW fungus, *Podosphaera leucotricha*, overwinters in buds of apple trees, protected by the bud scales. When the buds open, they give rise to severely mildewed shoots. The spores formed on these begin a new disease cycle.

Perennation in association with the host is the general means by which plant pathogenic viruses survive. All viruses require living host cells to multiply; few survive in crop debris. An exception is tobacco mosaic virus, which, as its name implies, causes a mosaic pattern of light and dark patches on infected tobacco leaves. Similarly, few plant pathogenic bacteria can live apart from their hosts. Some exceptions are the crown-gall organism, *Agrobacterium tumefaciens*, which survives in soil, and the bacterium causing cotton blight, *Xanthomonas malvacearum*, which survives in dry crop debris. In contrast, many fungi form thick-walled spores or fruiting bodies that enable them to survive adverse conditions, or they live saprophytically on crop debris or on organic matter in soil.

Pathogen Dispersal. Fungi such as rusts and smuts are examples of pathogens whose spores are dispersed by rain and wind. Diversity of inocula is seen at its extreme in the rust fungi, especially *Puccinia graminis*, which causes stem rust of cereals. On wheat, *P. graminis* first produces orange-brown masses of spores that are dispersed by wind and infect other wheat plants. Later in the season it forms overwintering black spores, which are not able to infect wheat. In the spring these germinate to form small, colorless, thin-walled spores, which can infect only barberry, *Berberis*, or some *Mahonia* species. On these hosts two further distinct spore types are produced, but neither can infect the host on which it is formed. One type is involved only in fertilization. The other infects wheat.

Other pathogens, such as the anthracnose fungi, are distributed primarily through insect activity. The fungus *Ceratocystis ulmi*, which causes Dutch elm disease, is carried from tree to tree by certain species of bark-boring beetles. These beetles become contaminated with spores because the fungus grows well in the galleries these insects make in elm bark. When the beetles emerge and feed on young twigs of healthy elms, they introduce the fungus, which then multiplies in the vascular system, causing rapid death of the tree.

Many viruses are also spread by insects, especially aphids, leafhoppers, and whiteflies. The insects acquire the viruses when feeding on an infected plant and transmit them when feeding on a healthy plant. Pathogens can take advantage of the physical damage that is caused by scale insects and other insect pests, as well. Humans also help spread pathogens by handling infected and healthy plants in succession, by distributing infected planting material, and by transferring contaminated soil from one site to another on agricultural machinery.

Pathogen Specificity. Some pathogens, such as *Ceratocystis ulmi*, which is restricted to elm species, can colonize only a few hosts. Others, such as the fungi *Pythium ultimum* and *Rhizoctonia solani*, which cause damping-off, successfully colonize the seedlings of many diverse plant species. The horticultural development of particular varieties (cultivars) of a plant species to satisfy commercial requirements, such as high yield, has led to the appearance of different races of a single pathogen, which are specialized in their ability to attack the different cultivars. The extensive cultivation of one type of cultivar (monoculture) provides a uniform host population within which these races can develop. Many races now exist of *Puccinia graminis* and of *Phytophthora infestans*.

Control

The amount of disease in a crop at any one time depends on the amount of the pathogen initially present (initial inoculum), the rate at which it infects plants (infection rate), and the time available for infection. The aim of most control methods is to counter these elements by excluding any initial inoculum, by reducing the amount of inoculum, or by reducing the infection rate.

Exclusion. *P. infestans* probably came to Ireland on potatoes from the New World. Today most countries not only have regulations to prevent the introduction of foreign pathogens, but they also have special quarantine sites where imported planting material can be grown and inspected. Disease control by legislation is often extended to restrict the movement of infected material within a given political territory. The same principle of exclusion is applied to the growing of crops by planting only pathogen-free stock.

Reducing Inocula. Sometimes pathogens are introduced into an area despite all attempts to exclude them. The fire blight bacterium, *Erwinia amylovora*, well known for more than a century as a serious pathogen of apples and pears in the United States, suddenly appeared in the Kent orchards of southeast England in the late 1950s. The coffee leaf rust fungus, *Hemileia vastatrix*, known in the Old World since the 1860s, appeared in Brazil in 1970. The problem in these instances was how to reduce the inocula quickly. The obvious solution was to destroy infected plants. This was attempted in England for fire blight control. It has not been entirely successful for two reasons: it has proved impossible to monitor individual apple and pear trees in home gardens, and the presence of alternate hosts—the bacterium can also infect *Crataegus* species, which are widely planted as ornamentals. The mobility, reproductive patterns, and behavior of insect vectors, or carriers, of the pathogen also work against the success of an eradication scheme, as has been apparent in the unsuccessful attempts to eradicate Dutch elm disease.

The long-distance spread of spores is another major obstacle. In the United States the local eradication of barberry, the alternate host of *Puccinia graminis*, has not eliminated stem rust of wheat because the spores can be carried many kilometers by wind.

Two other ways of reducing inocula are used that are more appropriate for controlling established pathogens. Some wheat cultivars are resistant to certain races of *P. graminis* but are susceptible to others. This resistance is of an "all-or-nothing" type and is called race-specific resistance. Planting such a cultivar reduces the effective number of inocula, because if 99% of the spores entering the field are of races to which the cultivar is resistant, then the rust disease must develop from the remaining 1%. It is relatively easy for plant breeders to test seedlings in the greenhouses for this type of resistance. The genes for resistance are often derived from wild *Triticum* species (relatives of wheat). The aim is to incorporate several genes into a commercially acceptable cultivar, which is then crossed with other cultivars to confer resistance to all existing races. There is one major disadvantage in this approach. If a new race of the pathogen *P. graminis* develops by mutation and is able to infect a cultivar, that cultivar succumbs completely.

Fungicides are now used that are absorbed by and become distributed within the plant. A plant treated with such a systemic fungicide resembles one with race-specific resistance. In both types, the fungus is killed upon entry, and effective inoculum is thus reduced. In race-specific resistance, this is caused by a gene-controlled defense mechanism; in systemic treatment, this is caused by a chemical disruption of some part of the pathogen's metabolism. Just as new fungoid races can arise to overcome the resistance of specific genes, however, new races can develop that can grow on plants treated with systemic fungicides. This does not mean that such materials are useless. On the contrary, systemics are another way to combat plant disease.

Reducing Infection. Two control methods are used to reduce infection rate. One is the classical approach of applying chemicals to foliage. These chemicals inhibit the growth of infective materials that land on the foliage. Unlike systemic fungicides, these pesticides (see PESTICIDES AND PEST CONTROL) are not absorbed and so become diluted by plant growth and the action of rain and wind. They seldom give 100% control, but they do delay the epidemic. Most fungicides act in this way. The second method is relatively new. Some wheat cultivars are susceptible to all races of *P. graminis*, but rust develops rather slowly on them. Thus, a level of resistance exists not specifically associated with a particular race. Cultivars with this "race-nonspecific resistance" react similarly to any new race of the pathogen that arises. While sustaining a certain amount of disease, they do not succumb disastrously as do cultivars with race-specific resistance.

disinfectant see ANTISEPTIC

Dismal Swamp The Dismal Swamp, or Great Dismal Swamp, is an area of water, grassland, and bogs approximately on the U.S. Atlantic coastal plain. Lying roughly between Norfolk, Va., and Elizabeth City, N.C., it is about 60 km (37 mi) long and between 16 and 24 km (10 and 15 mi) wide, at an elevation of 3 to 6 m (10 to 20 ft). Once almost twice its present size, the swamp has been reduced in area by drainage and by fire and lumbering. Remaining portions are still heavily wooded.

Lake Drummond, in Nansemond County, Va., is the swamp's central freshwater lake. Wildlife is abundant, and the swamp is noted for its fishing and hunting, particularly of deer, bear, and raccoon. A 35-km (22-mi) canal used primarily for recreational boating runs from Norfolk to Elizabeth City. Built between 1790 and 1828, it connects Chesapeake Bay with Albemarle Sound. The swamp was visited by William Byrd in 1728 and was surveyed (1763) by George Washington.

Disney, Walt The creator of the cartoon character Mickey Mouse and a film innovator who won a record 30 Academy Awards, Walter Elias Disney, b. Chicago, Dec. 5, 1901, d. Dec. 15, 1966, was also among the most successful American entrepreneurs. The entertainment empire he founded includes two giant amusement parks (Disneyland and Walt Disney World) as well as his film studios. The licensing of reproduction rights to Mickey Mouse and other Disney characters for use on clothing, books, and innumerable other objects makes the Disney fantasies ever present in American life and much of the rest of the world.

Disney's childhood was spent in Marceline, Mo. (whose main street may have inspired the nostalgia-laden main streets of the amusement parks), and in Kansas City, Mo., where he met Ub Iwerks, who became a Disney collaborator. When their Kansas City animation studio failed in 1923, Disney founded a new studio in Hollywood, and Iwerks became chief artist and special-effects designer.

By 1928, Disney and Iwerks had perfected the immortal Mickey Mouse, who made history the same year in *Steamboat Willie*, the first cartoon with sound. (Mickey's squeaky voice was supplied by Disney.) In succeeding Disney cartoons—including the famous series *Silly Symphonies*—the characters moved to the rhythm of a prerecorded soundtrack, making possible a humorous and ingenious match of motion to sound (see ANIMATION). By the mid-1930s all Disney cartoons were made in color, and his stable of animal characters (Donald Duck, Goofy, Pluto, and the rest) was almost complete.

Walt Disney, an American motion picture producer and animator, applies the finishing touches to a sketch of his most famous cartoon character, Mickey Mouse, introduced in 1928. Disney pioneered in the development of full-length animated films.

The world's first feature-length animated film, Disney's *Snow White and the Seven Dwarfs* (1938), proved a stunning financial success and was followed by *Fantasia* (1940), which combined classical music with animated sequences, *Pinocchio* (1940), *Dumbo* (1941), and *Bambi* (1942). *The Reluctant Dragon* (1941) was the first of many Disney films to use a sophisticated matte technique that allowed live and cartoon characters to appear together.

In the 1950s, Disney turned to films with live characters, such as *Treasure Island* (1950), *20,000 Leagues Under the Sea* (1954), and the musical fantasy *Mary Poppins* (1964); to nature films whose fine photography was marred for some critics by the sentimentality of approach; and to films produced for television—the *Davy Crockett* series, for example. TV's "Mickey Mouse Club" has revived the old cartoon figures for several new generations of children. The Disney Channel offers "Disneyfied" entertainment to cable-TV viewers.

Disneyland and Walt Disney World Disneyland and Walt Disney World are probably the most popular and profitable theme amusement parks in the United States, attracting millions of tourists annually. Created by the film and television producer Walt Disney, Disneyland opened in Anaheim, Calif., in 1955. Walt Disney World, a 10,800-ha (27,000-acre) tract near Orlando, Fla., opened in 1971 and quickly replaced Niagara Falls as the world's leading honeymoon resort. Both parks open onto a turn-of-the-century Main Street, U.S.A. Visitors ride, stroll, or boat through their choice of synthetic Disney fantasies, each of which celebrates a shiny, scrubbed-clean, old-fashioned America; or introduces almost-real characters out of fairy tales and Disney cartoons and films; or creates the settings in which visitors can experience their own adventures.

Expanded continuously since its opening, Walt Disney World consists of the fantasyland, Magic Kingdom; Epcot Center, with its futuristic designs for living and array of international restaurants; and Disney-MGM Studios, containing genuine film studios where real films are made, and the Great Movie Ride, a nostalgic trip through movie history featuring famous cinema scenes peopled by computerized "audio-animatronic" figures that look, move, and talk like their flesh-and-blood models.

dispersion When white LIGHT falls obliquely on a medium such as a glass PRISM or a sphere of plastic, it is refracted, or bent, and separated into its colored components; this phenomenon is called dispersion. All materials that transmit light are characterized by a number called the refractive index, which is related to the velocity of light in that medium. Red light moves more rapidly than blue in all media. As a result, the red light is bent less than the blue light, and other colors fall in between. After passing through the medium, white light is dispersed into its components.

Disraeli, Benjamin, 1st Earl of Beaconsfield [diz-ray'-lee] Benjamin Disraeli, b. Dec. 21, 1804, d. Apr. 19, 1881, who early in his career was written off as a foppish Jewish scribbler of no fixed political abode or principles, "climbed to the top of the greasy pole" of British politics as Conservative prime minister in 1868 and 1874–80. He was of Sephardic Jewish descent, but in 1817 his father, the writer Isaac D'Israeli, converted the entire family to Christianity.

In the 1820s and '30s, Benjamin published numerous novels, histories, and political writings. In his writings he revealed dreams and visions concerning his race and the "Asian mystery" that were alien to both the business and ruling classes of Britain. He elaborated an anti-Whig picture of British history since the Reformation, pointing to the failure of church and state to fulfill their duty of improving the condition of the people. This duty was the theme of the "Young England" novels, *Coningsby* (1844) and *Sybil* (1845); later Disraeli linked it with the maintenance of constitution and empire as the theme of British conservatism.

After four unsuccessful attempts, Disraeli was elected to Parliament in 1837. At first he was a disappointed office seeker, but his devastating attacks on the Conservative government of Sir Robert Peel as an "organized hypocrisy" made him, in fact, the incongruous Commons leader of the majority of Conservatives, who opposed repeal of the Corn Laws.

Official party leader in the House of Commons from 1850, Disraeli served as chancellor of the exchequer in the minority governments of the 14th earl of Derby (1852, 1858–59, 1866–68) and finally succeeded Derby as prime minister briefly in 1868. In 1867 he had been largely responsible for the second Reform Act, which extended parliamentary suffrage to borough householders. In opposition after 1868, he gained the support of the middle and working classes against the radicalism of William Gladstone's Liberal government. In the elections of 1874, the Conservatives won their first majority since 1841.

Benjamin Disraeli, leader of Britain's Conservative party, served two terms as prime minister (1868, 1874–80). He combined domestic policies of social reform with foreign policies dedicated to the expansion of Britain's imperial possessions.

The Conservative ministers of Disraeli's government put through useful trade union and social reforms, especially in the areas of public health and factory legislation. Disraeli himself, now old and ill, concentrated on foreign and imperial questions. His purchase (1875) of a controlling share of the Suez Canal stock strengthened British interests in the eastern Mediterranean, but his handling of the Eastern Question (1878) is controversial (see Berlin, Congress of). In 1876, in a proclamation of British imperial interests, Queen Victoria assumed the title empress of India; greatly pleased, the queen, who adored Disraeli, created him earl of Beaconsfield.

An economic depression, the unpopularity of the colonial wars in Africa and Afghanistan, and Gladstone's crusade against Turkish atrocities in the Balkans sent Disraeli into opposition again in 1880. He died a pessimist the following year; he remains a source of inspiration to reforming Conservatives, especially in bad times.

D'Israeli, Isaac Isaac D'Israeli, b. May 11, 1766, d. Jan. 19, 1848, father of the British statesman Benjamin Disraeli, was the English author of numerous volumes of literary history and anecdotes. These include the six-volume *Curiosities of Literature* (1791–1834) and the two-volume *Calamities of Authors* (1812–13). He also published poetry and three novels, as well as histories of James I (1816) and Charles I (5 vols., 1828–30).

dissociation (chemistry) [dis'-oh-see-ay'-shuhn] Dissociation is the process in which one single substance splits into two lesser parts. In a chemical sense, dissociation signifies a chemical change that involves one substance breaking into two new substances. In a simple example, a diatomic molecule of hydrogen, H_2, can split into two hydrogen atoms, H. Often an immediate reverse association begins to occur and there is established a dynamic equilibrium between the reactants and products.

The use of two arrows in opposite directions designates the equilibrium. For example, phosphorus pentachloride dissociates in a confined volume into phosphorus trichloride plus chlorine and establishes the following equilibrium:

$$PCl_5 \rightleftharpoons PCl_3 + Cl_2$$

The formation of ions in solution in water is also described as dissociation. The dissociation into ions of acids such as hydrochloric acid, HCl, bases such as sodium hydroxide, NaOH, and salts such as sodium chloride, NaCl, was first recognized in 1884 by Svante Arrhenius as the reason for the electrical conductivity of their water solutions:

$$HCl_{(aq)} \rightarrow H^+_{(aq)} + Cl^-_{(aq)}$$
$$NaOH_{(aq)} \rightarrow Na^+_{(aq)} + OH^-_{(aq)}$$
$$NaCl_{(aq)} \rightarrow Na^+_{(aq)} + Cl^-_{(aq)}$$

Substances that form ions in water solution are known as electrolytes. The conduction of electricity by their solutions is made possible by motion of the ions.

See also: Chemical kinetics and equilibrium; Electrolysis.

dissociation (psychology) Dissociation is an internal process by which certain ideas or behaviors are in some way disconnected from the main body of a person's beliefs. The extreme case of dissociation is the alternation of personalities—the so-called split personality. Dissociation is also manifested in sleepwalking, in symptoms of psychosis such as delusions, in symptoms of neurosis, in some forms of amnesia, and in automatic writing—a process in which the hand writes messages without conscious control. Many phenomena of hypnosis are also the result of dissociation.

dissonance A dissonance is any combination of musical tones not in a state of repose (consonance) that produces the feeling that movement or resolution toward the consonant state is required. Aurally, the distinction between consonance and dissonance is subjective, a difference between agreeable and disagreeable sounds. Dissonance makes the music more interesting because it breaks up otherwise unrelieved repetitions of the primary triads. The earliest categorization of consonance and dissonance was made by the Greek philosopher and mathematician Pythagoras of Samos.

distance, astronomical The earliest known determinations of distances from the Earth to other celestial bodies were those made of the Sun and the Moon by Aristarchus of Samos (*c.*310–230 BC). He found the Moon to be at a distance of 40 times the Earth's radius and the Sun to be 19 times more remote than the Moon. This estimate of the Moon's distance was greatly refined by Hipparchus about 130 BC, but Aristarchus's value for the Sun's distance, although in error by a factor of 20, was accepted for nearly 2,000 years. The first reasonably accurate solar-distance determination was made in 1672 by the astronomer Giovanni Domenico Cassini.

Direct Methods

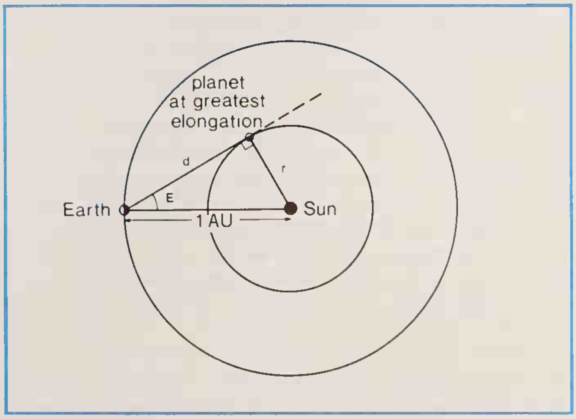
In astronomy the traditional method for determining the distance of a celestial body is to measure its parallax, which is the difference in direction of an object as seen by an observer from two different locations. The greatest precision is obtained by choosing the longest possible baseline. For the Sun and Moon, two widely separated points on the Earth are chosen as observation stations. For objects beyond the solar system, the semimajor axis of the Earth's orbit is the adopted baseline. Using such methods, as well as radar ranging of the planets Venus and Mars, a value for the Sun's distance of 149,597,870 km (92,955,770 mi) has been determined. Known as the astronomical unit (AU), this mean distance corresponds to a parallax of the Sun of 8".794148. Radar and lunar laser ranging of the Moon give its mean distance as 384,399.1 km (238,854.5 mi).

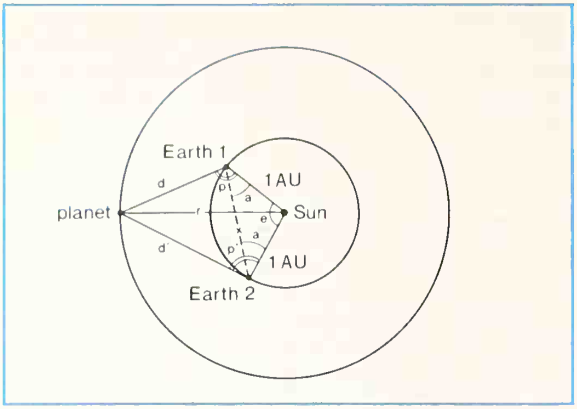
Distances beyond the solar system are expressed in units of a parsec, which is the distance an object would have if its parallax were equal to 1 arc second, with the astronomical unit as baseline. One parsec is 30,857,000,000,000 km (19,174,000,000,000 mi). If the parallax, *p*, is expressed in arc seconds, the distance, *d*, in parsecs equals 1/*p*. One parsec equals 3.26 light-years.

Indirect Methods

Beyond a distance of 25 parsecs, the trigonometric parallax method is not, in general, sufficiently accurate, and

Trigonometry rules allow the distance r (in terms of astronomical units) between the Sun and an inner planet to be determined once the angle of elongation ε is measured. This angle is measured when the planet is at itsgreatest angular separation from the Sun as viewed by an observer on the Earth. At this time the lines from the planet to the Sun and to the Earth are at right angles to each other.





Kepler's method of finding the distance r *between the Sun and an outer planet also uses trigonometry. The key measurements are the planet's angular separations* p *and* p' *from the Sun as the planet makes two successive passes through some point in its orbit. The angle* e *is determined from the time it takes the Earth to move simultaneously from 1 to 2, a motion including one or more orbital revolutions.*

other methods have been devised. If a star's intrinsic luminosity is known, its distance can be determined from its apparent magnitude because the light received from a star varies inversely as the square of the distance. Much effort is thus expended in determining stellar luminosity from spectra or COLOR INDEX.

Among the special types of stars that have figured in the determination of large distances in space are the pulsating variables, the so-called Cepheids. The discovery of the period-luminosity relation of these objects has made them important indicators of distance. The brightest Cepheids are extremely luminous and therefore visible and recognizable to distances of several million parsecs.

The distances to the spherical star systems known as globular clusters (see CLUSTER, STAR) have been determined from the short-period pulsating variable stars known as RR Lyrae stars, which have a mean absolute magnitude of 0.5. The method of photometric parallaxes based on the 25 brightest stars in these systems is another way of determining their distances.

The determination of the distances to galaxies (see EXTRAGALACTIC SYSTEMS) depends on a series of methods in which the errors increase with distance. For the nearer galaxies, the Cepheids determine the distances; for those up to a distance of 20 million parsecs, the bright red and blue supergiant stars, novas, and supernovas are used. Beyond that limit, the RED SHIFT in the spectral lines of the galaxies determines the distances in accordance with Hubble's expansion law. The largest red shift measured for a galaxy, 3.8, indicates a distance of more than 15 billion light-years. The red shifts observed for QUASARS range from about 0.06 to more than 4.7. The latter figure indicates a recession of 93 percent of the velocity of light. The corresponding large distances, however, have not been confirmed directly and are a subject of debate among astrophysicists.

Distant Early Warning Line see MILITARY WARNING AND DETECTION SYSTEMS

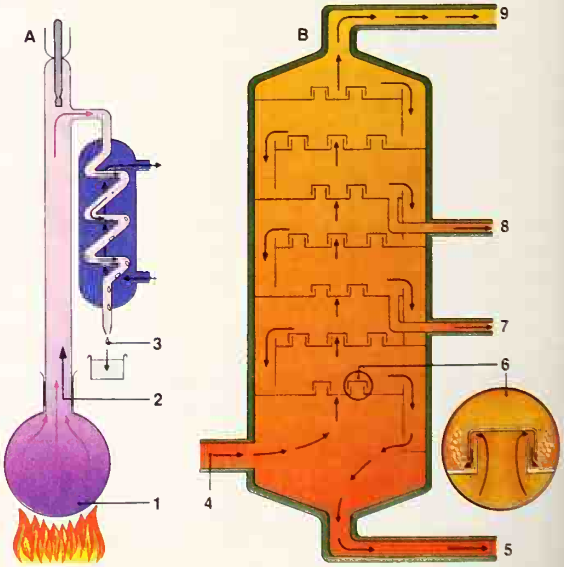
distemper see DISEASES, ANIMAL

distillation Distillation is the principal method for purifying liquid compounds. In this process, a compound is vaporized, the vapor is condensed, and the condensate (liquid) is collected in a separate container. Distillation is a useful technique for separating a liquid from impurities that have different boiling points or that are not volatile. Nonvolatile products may be isolated from a solution after evaporation of the liquid.

In order for a liquid to distill, it must be heated to boiling. As the liquid is heated its vapor pressure increases until it equals the applied pressure (usually atmospheric pressure, or 760 mm of mercury); the boiling point of a liquid is defined as the temperature at which its vapor pressure equals atmospheric pressure. When a pure substance is distilled at constant pressure, the temperature of the distilling vapor remains constant throughout if enough heat is supplied to ensure a uniform rate of distillation and if superheating is avoided.

Fractional distillation, or FRACTIONATION, is a method for separating several volatile substances from a mixture, such as petroleum. The vapor from the boiling mixture is passed through a vertical column that, in certain industri-

A liquid can be separated from a mixture by distillation (A). *The mixture* (1) *is heated until the desired liquid escapes as a gas* (2), *is liquefied in a water-cooled coil, and collected* (3). *Fractionating bubble-cap towers* (B) *separate crude-oil constituents. As oil enters* (4), *nonboiling tars are collected as residue* (5). *Less volatile substances liquefy as they pass through increasingly cooler liquid layers by way of bubble caps* (6). *A liquid layer is collected as it overflows* (7, 8). *The most volatile components exit at the top* (9).



al plants, may be more than 60 m (200 ft) tall. Continuous condensation and reevaporation cause the composition to change until a pure vapor is obtained at the top. Each component, or fraction, of the mixture is successively distilled in the process.

PYROLYSIS, the decomposition of substances such as wood or coal by heat in the virtual absence of air and the distillation of their volatile components, is also known as destructive distillation.

distilling (alcohol) see WHISKEY

distribution In STATISTICS, the distribution of a set of numbers consists of arranging the numbers in order of size, or in rank order. After statistical data have been gathered, they must be displayed so that they can be analyzed effectively. A distribution is a common and useful way of displaying data. It presents the set of values, with an indication of how frequently each value occurs. Because the frequency of occurrence of each value is given, the distribution is sometimes known as a frequency distribution. It may be displayed as a simple empirical frequency distribution, in which the values of the data are arranged along one axis and the frequency along the other.

When the population (the entire set of numbers being sampled) is large, the data can be described more simply by dividing the values into classes, or groups, usually of equal size; in this way, the number of classes to be considered is much less than the number of original values in the sample (see SAMPLING). When the data have been thus classified, they may be displayed in such graphical distributions as bar graphs, block graphs, frequency polygons, and HISTOGRAMS.

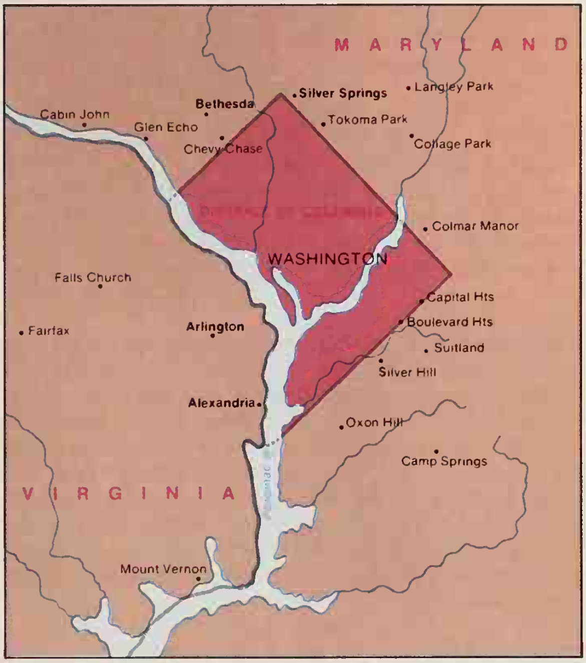
distributive law see ARITHMETIC

district attorney see PROSECUTING ATTORNEY

District of Columbia The District of Columbia is a federal district, coextensive with the city of WASHINGTON, D.C., capital of the United States. On July 16, 1790, Congress authorized the creation of a permanent federal capital not under the jurisdiction of any state, covering a 10-mi-square (16-km) area. The 100 mi^2 (259 km^2) originally included were ceded in 1791 by Virginia and Maryland. In 1846 the Virginia lands were returned to that state, and the district was reduced to its present area of 67 mi^2 (174 km^2). President John Adams moved the government there in June 1800; Congress first met there in November.

No provisions were made by the founding fathers for local government of the district. From 1802 to 1871 a mayor-and-council form of government was in effect. In 1871, Congress created a territorial form of government, with a governor appointed by the president. This was replaced in 1874 by a three-member commission appointed by the president.

In 1967 the district's government was reorganized, and a single commissioner (later called mayor), a deputy commissioner, and a 9-member city council were appointed by President Lyndon Johnson. A congressional act, subsequently approved (1974) by local referendum, provided for limited home rule and a popularly elected mayor and 13-member council. Congress maintains veto power over all the council's legislation. Congressional appropriations are paid to the district in lieu of taxes on federal property, and the president retains the right to appoint district judges. Marion S. Barry, mayor between 1979 and 1991, was convicted in 1990 for drug possession.



Since 1800 district residents have been denied full representation in Congress on the grounds that the Constitution guarantees representation only by senators and representatives from the states. In 1871 residents of the district won the right to send an elected nonvoting delegate to the House of Representatives, but this was revoked in 1874. It was restored in 1970, and Walter E. Fauntroy was elected delegate. (He served until 1991, when Eleanor Holmes Norton replaced him.) In 1978, Congress completed action on a proposed constitutional amendment that would have given the district congressional representation like that of the states, but the necessary 38 states failed to ratify this amendment by the Aug. 22, 1985, deadline. Legislation to grant the district statehood has been introduced in Congress. The right to vote for president and vice-president was granted to district residents in 1961 by the 23d Amendment.

district court In the U.S. judicial system, a district court is a court in which proceedings under federal law begin. Each court has jurisdiction over an area called a district, which may include part or all of a state. In addition, both the District of Columbia and Puerto Rico have district courts. About 90 U.S. districts exist.

Federal district courts hear both civil and criminal cases. These include, among others, antitrust cases and cases involving constitutional issues. Suits by citizens of one state against citizens of another may be tried in a district court, as may disputes between U.S. citizens and foreign governments or their nationals. Admiralty and bankruptcy proceedings arising under federal law are also initiated in district courts.

Dittersdorf, Karl Ditters von [dit'-urs-dorf] Karl Ditters von Dittersdorf, b. Nov. 2, 1739, d. Oct. 24, 1799, was an Austrian composer, violinist, and conductor. Dittersdorf toured (1763) Italy with Christoph Willibald Gluck. He was court conductor at Pressburg (now Bratislava) from 1764 to 1769 and at Johannisberg from 1769 to 1795. In Vienna, Dittersdorf played string quartets with Franz Josef Haydn and Wolfgang Amadeus Mozart. His numerous compositions include more than 100 symphonies, divertimentos, sonatas, oratorios, and comic operas.

Diu see GOA

diuretic drugs [dy-yur-ret'-ik] Diuretics are chemical agents that help the body to rid itself of excess fluids by increasing the rate of URINE production by the kidneys. Excess-fluid accumulation in tissues, also known as EDEMA, is symptomatic of a wide range of heart, kidney, liver, and other disorders. Such disorders must be addressed, but diuretic drugs may be used with other treatments.

Diuretics vary in the way that they alter the excretion of electrolytes by the kidneys; these electrolytes, such as sodium and potassium salts, are involved in the regulation of blood pressure. The drugs derive from a number of pharmacological groups, including steroids, sulfonamides, and thiazides. They must be chosen according to need; for example, a diabetic patient should probably avoid thiazides. Adverse reactions to diuretics include dizziness, numbness, rashes, electrolyte imbalance, and even shock, so their use in treating mild chronic conditions should be carefully considered.

divergence see CONVERGENCE

diverticulosis [dy-vur-tik-yoo-loh'-sis] Diverticulosis is an acquired disorder characterized by the presence of diverticula, small protrusions through the wall of the colon. These colonic protrusions, or multiple herniations, of the mucous membrane, especially in the sigmoid colon, pierce the outer muscular wall. Diverticula are frequently sites of inflammation, called diverticulitis. Symptoms include rectal bleeding, abdominal distension, pain, and gas. This disorder is probably caused by the absence of dietary fiber, or bulk, such as bran. It is treated with medications to relieve symptoms and by adding fiber to the diet.

divertimento [div-urt-i-men'-toh] A divertimento is a piece of chamber music, usually having from three to ten movements and a light, entertaining style. It was a characteristic form of late 18th-century music. A divertimento might be written for strings alone, woodwinds alone, or a combination of both. Movements were often short; some were written in the sonata form, whereas others were rondos or dances, usually minuets. Compositions resembling divertimentos were sometimes called SERENADES, or cassations.

dividend see STOCK (finance)

divination Divination is the practice of foretelling the future by means of alleged preternatural powers. It is based on the beliefs that the future is predetermined, that all things, however casual or accidental they might appear, have significance, and that the pattern of coming events can be read from them. The practice has been common from earliest times, often through the medium of a PROPHET, SHAMAN, SIBYL, or person temperamentally equipped to go into a state of trance.

Ancient diviners were asked to foretell the outcome of great undertakings, advise whether war should be declared, and recommend auspicious times for constructing temples, electing public officials, or passing important laws. The Egyptians and Babylonians held special classes of priestly diviners; the Greeks consulted ORACLES, especially at DELPHI; and the Romans had a state-sponsored college of augurs, a select group that read the future by studying the behavior of birds or the markings on the liver or entrails of sacrificed animals.

Divination includes all methods of fortune-telling: card reading, crystal gazing, palmistry. In ASTROLOGY the general direction of a person's life is read from the position of the stars at the time of his or her birth. Dream interpretation (see DREAMS AND DREAMING) was once a popular form of divination.

Divine, Father An American religious leader, Father Divine, b. *c.*1878, d. Sept. 10, 1965, was founder of the Peace Mission, a widely publicized black cult. Born George Baker, in Georgia, he had established himself by 1919 in Sayville, N.Y., as Father Divine. His Peace Mission moved to Harlem in New York City in 1933 and to Philadelphia in 1942. To his followers, Father Divine was the incarnation of God; his words were sacred. He reinforced their faith by lavishly providing food, lodging, and other practical aids for them in his "heavens." The movement declined after Father Divine's death.

Divine Comedy, The *La Divina Commedia* (*The Divine Comedy*), an enduring literary masterpiece, is an epic poem written in Italian by Dante Alighieri. Probably begun in 1307 and finished just before the author's death in 1321, it was originally entitled simply *Commedia.* The long narrative, divided into 100 cantos (more than 14,000 lines), is in three main sections: *Inferno, Purgatorio,* and *Paradiso.* Its vivid scenes and sharply drawn characters highlight Dante's imaginative journey through the circles of hell to the rim of purgatory, under the guidance of Vergil, into the paradise of heaven, led by his lady Beatrice, where he briefly glimpses God's glory. The surface narrative conceals an allegory of life on Earth and the pilgrim poet as a figure of Everyman. For his material Dante drew on a wealth of scriptural, patristic, classical, and medieval sources, as well as his own experiences. The poem is composed in *terza rima* (triple rhyme), employing rich imagery and flexible vernacular language. Of Homeric proportions, the work is infused with the emotional and intellectual ardor of medieval Catholicism. The greatest poem of the Middle Ages, it has a beauty and humanity that transcend its times.

Divine Office The Divine Office is the traditional cycle of daily prayer in several Christian churches. It consists of psalms, biblical readings, selections from religious writings, hymns, and prayers. Because it is arranged to be said at fixed hours of the day, it is sometimes called the Liturgy of the Hours. Morning Prayer (Matins or Lauds) and Evening Prayer (Vespers) are the best-known parts of the Office. The Roman Catholic and Eastern Orthodox churches use somewhat different cycles; the Anglican (Episcopalian) and Lutheran churches have adopted elements of the Roman Catholic office.

divine right According to the doctrine of divine right, which reached its peak of influence in 17th-century Europe, sovereigns were given their right to rule by God and were thus not accountable to their subjects. The English political theorist Sir Robert Filmer (*c.*1588–1653), author of *Patriarcha* (1680), was a principal exponent of this doctrine, which had evolved partly to check papal incursions into politics. James I and Charles I of England and Louis XIV of France justified many of their policies by invoking the theory of divine right.

diving Diving is a recreational or competitive athletic activity in which the participant leaps from above the water surface, executes simple to complex body motions while in the air, and enters the water headfirst or feetfirst. Although the diver may take off from any type of perch over the water's surface—from a poolside inches above the surface to cliffs 20 or more meters above the ocean—most diving, including all sanctioned competition, is done from springboards or platforms.

Diving as a gymnasticlike, acrobatic activity was developed in Europe during the 19th century, and the first competition took place in England about 1880. Men first dived in the Olympics in 1904, and women in 1912. Competition on the international level is governed by the Fédération Internationale de Natation Amateur (FINA; founded 1908), and U.S. competition, by the National Collegiate Athletic Association and the Amateur Athletic Union.

American Greg Louganis demonstrates the athleticism that made him the greatest diver ever. In both the 1984 and the 1988 Olympic Games, Louganis took gold medals in the platform and springboard events.

Dives. There are four basic parts to a dive: the run, the takeoff, the execution, and the entry into the water. These aspects are the only ones judged in competition. The third part, which takes place in the air, is by far the most variable and consists of one or more of four basic body positions: layout—body straight, legs extended; pike—body bent at waist, legs straight; tuck—legs against chest, hands holding shins; and free—position changing, as in most twisting dives. Although more than 70 different dives are recognized by the FINA, each falls into one of six basic categories: forward—body faces water on takeoff and rotates in same direction; back—body faces board but rotates toward water; reverse—body faces water but rotates back toward board; inward—body faces board and rotates in same direction; twist—body spirals laterally, that is, rotates around its long axis; and armstand—for platform only, armstand (upside down) takeoff.

Competition. A springboard, with adjustable fulcrum, is 1 or 3 m (3 or 10 ft) above the water surface. The platform, inflexible, is set at 5–10 m (16–33 ft) above the surface. For Olympic and other major competition for both men and women, the 3-m and 10-m heights, respectively, are used. In large meets 7 judges preside, and in others 5 are considered sufficient. Each judge issues a mark, from 0 (worst) to 10 (best), for each dive, and a final mark for the dive is arrived at using a set mathematical formula that takes into account the universal degree-of-difficulty factor for that particular dive. Some dives are more difficult to perform than others, and this must be reflected in the tabulation (but not in the judging). Each competing diver must perform compulsory dives (low degrees of difficulty) and optional dives (chosen by the diver, usually with higher degrees of difficulty) in each of two or three rounds of competition. The person with the greatest number of points for the final round is the winner of the competition.

diving, deep-sea Deep-sea diving is an activity in which a person can descend deep underwater and remain there for a period of time with the aid of an external air supply. Down to about 100 m (328 ft), such commercial divers as those working in shipyards usually wear SCUBA DIVING equipment. Below that level, however, safer, more complex gear must be worn.

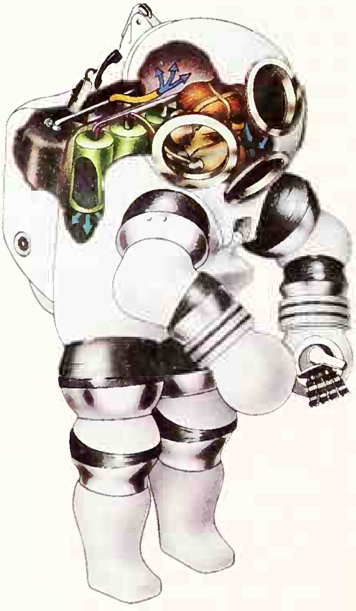
Underwater Observation and Work

Deep-sea diving is attempted either for underwater observation or to accomplish certain types of work. Underwater surveying of ships, wrecks, seafloor structures, and pipelines is a major business. Marine geologists and biologists, as well as archaeologists seeking submerged ruins, depend on deep-sea diving techniques. Construction divers perform numerous underwater tasks: welding on submerged pipelines, the servicing of seafloor oil wellheads, the erection of marine structures, and the retrieval of lost drilling equipment and other apparatus. Salvage divers remove valuable or potentially polluting cargoes from sunken ships; and they install patches, close doors and hatches, and rig-lifting cables in order to raise sunken ships or free stranded ones.

Diving Techniques

Two basic types of deep-sea diving exist: one in which the diver wears what is known as a JIM suit, and one that is called helmet diving. In both types the diver is tethered to the surface.

JIM Suit. The JIM suit was invented by Joseph Peress in 1922 and is named for Jim Jarrett, who made the first experimental dives with it in the 1920s. At that time the suit was successful to a depth of 145 m (477 ft), but with a modern JIM suit (see illustration) a diver is able to descend to depths of 610 m (2,000 ft). The suit is constructed of a magnesium alloy with a fiberglass epidermis, and it has a 20-hr self-contained breathing apparatus. The suit is set at 1 atmosphere of pressure, and therefore no decompression time is necessary when the diver ascends to the surface. Despite the suit's bulk (413 kg/910 lb), it is fairly maneuverable underwater.



A modern deep-sea, pressure-resistant diving suit, or JIM suit, allows a diver to carry an air supply and to breathe at normal atmospheric pressure. Use of normal air pressure enables a diver to return rapidly to the surface without fear of "bends" or other pressure-related ailments. The suit can withstand water pressures at depths up to 610 m (2,000 ft) and carries a 20-hour oxygen supply. The suit has jointed legs and arms that allow movement. Hand-controlled external metal fingers can be used to manipulate tools.

Helmet Diving. Helmets are used in cases where conventional-scuba-gear mobility is not needed, but where additional weight is necessary—as in strong ocean currents. Helmet divers can descend to great depths, but the deeper the descent the greater the decompression time upon ascending. Divers now use sophisticated fiberglass or plastic helmets. These helmets include a neck ring that mates to a neck seal or to a rubber or canvas wetproof suit. Suits for use in frigid waters contain a provision for supplying heat to the diver. The breathing medium reaches the diver from compressors on the deck of a ship or from high-pressure gas tanks on a submerged capsule or bottom habitat. The system used to supply gas to the helmet diver is called free flow: to regulate the flow and achieve adequate ventilation the diver manipulates valves on the helmet or weight belt.

The Breathing Medium

Air is not safe to use as the breathing medium at depths much below 76 m (250 ft) because nitrogen, the inert gas in air, has a pronounced narcotic effect when breathed under high pressures. Pure oxygen causes a reaction similar to a convulsion at depths below 20 m (66 ft), and diving using oxygen alone is not performed at depths greater than 10 m (33 ft). To prevent nitrogen narcosis and oxygen toxicity, deep-sea divers use carefully designed mixtures of oxygen and inert gases such as helium, argon, neon, or hydrogen.

A third physiological phenomenon faced by the diver is decompression sickness, more commonly called "the BENDS," a potentially lethal condition caused by too-rapid ascent. To prevent the bends, divers time their rate of ascent according to a decompression schedule.

See also: BATHYSCAPHE; BATHYSPHERE.

diving birds Diving birds are those which plunge into water to catch fish or other food. They may enter the water from flight, as does the brown pelican (*Pelecanus occidentalis*), or they may dive from the surface of the water. Most probably evolved from BIRDS already adapted for swimming that were equipped with such adaptations as webbed or lobed feet for propulsion.

Some diving birds—for example, the extinct Hesperornithiformes of the Cretaceous Period—propelled themselves with their feet. They were large, streamlined, flightless birds with teeth for grasping slippery prey. Today the cormorants (family Phalacrocoracidae), loons (Gaviidae), and grebes (Podicipedidae) are the major groups of foot-propelled diving birds. Their bodies are streamlined for underwater passage, with the hind limbs drawn in close to the body. The ducks (Anatidae) range from the nondiving dabbling ducks to such well-adapted divers as the ruddy duck of North America.

Other diving birds are wing-propelled. Like air, water is a fluid, though much more dense; thus, underwater wing-propulsion may be regarded as a specialized form of flight. This characteristic is found in the diving petrels

Diving birds are specially adapted for pursuing fish under water. Some, such as the rhinoceros auklet (above) *propel themselves through the water with their wings and can stay under for several minutes. Others, such as the great cormorant* (right) *use their webbed feet for propulsion. In the Orient, this cormorant is sometimes kept on a leash and trained to catch and retrieve fish.*

(Pelecanoididae) of the southern oceans and in the auks (Alcidae) of the Northern Hemisphere. The majority of these birds can fly in the air as well as underwater, although the recently extinct great auk (*Pinguinus impennis*) lost its ability to fly, as did the penguins (Spheniscidae) of the Southern Hemisphere.

divining rod see DOWSING

division (mathematics) see ARITHMETIC

division (military) In military terminology, a division is an ARMY unit, consisting of 10,000 to 20,000 soldiers, usually under the command of a major general, and containing all necessary arms and support services. The French, in the late 18th century, were the first to organize their armies in divisions. Modern armies have both armored and INFANTRY divisions that are similar in composition, although armored divisions employ a greater number of tanks. An infantry division includes artillery, armored, engineering, and service units, as well as foot soldiers. During campaigns, divisions—with supporting troops and services—are formed into field armies or corps.

divorce Divorce is a way of dissolving a legal marriage that permits the partners to remarry if they choose. It differs from an annulment, which declares a marriage invalid because of some defect in the contract. Divorce involves the recognition that a marriage has irreparably failed and that at least one of the partners has no desire to continue the marital relationship.

Divorce is obtained in the modern world through action in a court of law. In other times and societies, divorce has been a matter of religion or custom. Among some peoples divorce is a ritual; typically, it involves the symbolic breaking of some object such as a pot or a tool. In some societies couples draw up a divorce contract; the two parties and their families work out a mutually satisfactory arrangement that can be enforced through legal sanctions. In still other societies divorce is mainly an economic affair; usually it involves returning the payments made at the time of the marriage. In traditional Eskimo society, the family simply divided into two households.

Historical Background

The marriage and divorce institutions of the West are derived from ancient Hebrew and Roman sources. In Jewish law, a wife did not have the right to divorce her husband, but she did have the right to remarry if her husband divorced her.

In the Roman Empire, marriage was not a legal formality; a man and a woman simply began to live together in a permanent household. The only legal requirements were that the parties be citizens above the age of puberty and that they have the consent of their families. Both the husband and the wife possessed property separately. Either could put an end to the marriage; the law required only a clear indication of the intent to divorce, such as a formal letter.

The early Christian emperors of Rome began to bring marriage and divorce under the authority of the law. JUSTINIAN I, the lawgiver of the 6th century, sought to impose the church's view of divorce but had to back down because of public protest. In the eyes of the Christian church, marriage was indissoluble.

Canon law concerning divorce could be summarized by the phrase from the marriage ceremony: "What therefore God has joined together, let not man put asunder" (Matt. 19:6). When Martin Luther and other Protestants broke away from the Roman church in the 16th century, they adopted a different view of marriage. Luther called it "an external worldly thing, subject to secular jurisdiction, just like dress and food, home and field." The Protestants, therefore, permitted divorce on specific grounds, such as adultery, cruelty, or desertion. In England a different tradition prevailed. Legal divorce was instituted after HENRY VIII broke away from the Roman Catholic church, but until 1857 it was obtained through Parliament rather than through the courts.

Divorce in the United States

The early American settlers brought with them three different views on divorce: the Roman Catholic view that marriage was a sacrament and that there could be no divorce; the English view that divorce was a legislative matter; and the Protestant view that marriage and divorce were secular matters to be handled by the civil authorities. Virginia and the southern colonies did not recognize divorce at all. By the 1690s, Massachusetts recognized seven grounds for divorce.

The Constitution of the United States did nothing to limit the rights of the states to enact their own laws governing marriage and divorce. Despite several efforts to amend the Constitution, to allow Congress to pass federal legislation on divorce, to this day the states retain separate laws.

Popular attitudes toward divorce changed as the United States became urbanized and more secular. The increasing acceptance of divorce was reflected in court interpretations of existing laws and in new legislation enacted by the states. Two tendencies merged, making possible the establishment of new and easier grounds for divorce. The focus of state divorce legislation shifted from specifying legal grounds for divorce to criteria concerning the breakdown of the marital relationship. This could be seen in provisions that allowed divorce for alcoholism, drug addiction, or nonsupport. Another tendency was to permit divorce if both parties gave evidence of their desire by voluntarily separating and living apart for a specified period of time. Thus in 1967, New York allowed divorce for couples who had been legally separated for 2 years, eliminating the search for a guilty party. In 1969, California permitted divorce when "irreconcilable differences" arose, thus becoming the first state with a "no-fault" divorce law. Nearly all the other states soon added no-fault divorce options to their existing laws.

Divorce Rates

Published statistics show that the United States has the highest divorce rate in the world, but such statistics tend to be misleading. Statisticians speak of the "crude" divorce rate—that is, the number of divorces per 1,000 population. An even better measure is the number of divorced persons per 1,000 "population at risk" of divorce—that is, the total number of persons who are in fact married at the time. In 1987 in the United States, there were 123 divorced persons for every 1,000 married persons, or only about 12 percent of the married population.

Anthropologists report that many societies have even higher divorce rates than the United States. For example, the Kanuri of Nigeria would have a divorce rate approaching 100 percent if some married people did not die young. The belief that high divorce rates produce social disorganization is also open to argument. Much depends on the arrangements society makes for those families which experience divorce.

The Experience of Divorce

Divorce can be a devastating experience. While the divorce is in progress, and for some time afterward, both parties are likely to feel personally rejected, cheated in the economic arrangements, misrepresented legally, bitter about the coparental arrangements, lonely because they have lost friends, and afraid of living alone.

In a sense, the two people involved must separate on several different levels. On the psychological level each must learn to be without a person whose presence has been an everyday part of life. In the legal proceeding, the parties must often transmute their differences into the artificial grounds that will support the divorce action. In the social sphere they must make new friends and give up old ones with whom they no longer feel comfortable. Economically they must split up their property and establish separate households; the husband may be required to pay support for the children, and perhaps for the wife as well (although in some cases it may be the wife who supports the husband). As parents, they must accept some arrangement for custody of the children.

In the United States, the mother traditionally has been granted custody of the children unless she is found unfit by the courts. The father is usually awarded the right to visit the children regularly. Prolonged and bitter struggles for legal custody have often scarred both parents and children. In extreme cases, the parent losing a custody conflict may even resort to kidnapping his or her own children.

In recent decades, however, other patterns of child custody have emerged alongside the old. Some mothers have voluntarily relinquished custody in order to pursue other goals, or because they believe the children may fare better with the father. Joint custody has also become more common, with parents sharing responsibility for the upbringing of their children, even after remarriage.

Children are distressed when their parents divorce. Children under the age of 5 may react with rage and grief, as if they themselves were being divorced by their parents. Older children grasp the situation better but sometimes tend to blame themselves. Adolescents are likely to be angry at their parents and to feel socially embarrassed by the breakup. Many children, whatever their age, seem to emerge from the experience without permanent ill effects if the parents adjust reasonably well. Some studies indicate that children of divorce are more likely than others to receive poor grades or become delinquent; other studies suggest that these consequences are less the result of divorce than of a bad home life. If the atmosphere at home is bad, it may make little difference whether the parents remain together.

Notwithstanding the higher divorce rate, the motherless or fatherless family is less common today than in the 19th century. This is because, although few families in the 19th century were broken by divorce, many were broken by death. Recent studies of stepparent families have found that the children were as happy, productive, and successful as children in intact families.

Dix, Dorothea The American social reformer Dorothea Lynde Dix, b. Hampden, Maine, Apr. 4, 1802, d. July 17, 1887, worked to improve the institutional treatment of the insane. Through her crusading investigations state mental hospitals were founded or expanded throughout the United States and in Canada. She also made important recommendations in penology. Dix was superintendent of Union army nurses during the Civil War.

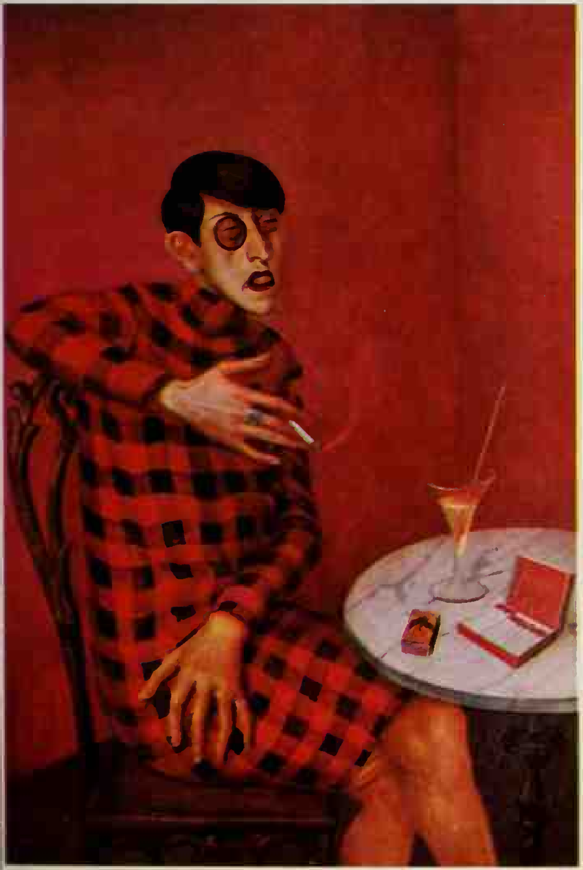
Dix, Dorothy Dorothy Dix was the pen name of Elizabeth Meriwether, b. Woodstock, Tenn., Nov. 18, 1870, d. Dec. 16, 1951, one of the best-known columnists of the early 1900s. Her column of advice to the lovelorn, "Dorothy Dix Talks," was first carried by the *New Orleans Picayune* in 1896. It began appearing in 1901 in William Randolph Hearst's *New York Journal* and was later syndicated. Recognizing Dix's rapport with the public, the Hearst editors assigned her to cover a number of sensational murder trials.

Dix, Fort see FORT DIX

Dix, Otto The German artist Otto Dix, b. Dec. 2, 1891, d. July 25, 1969, is best known for his devastating images of German life under the Weimar Republic. His earliest paintings reveal the influence of Die Brücke, cubism, and futurism. While serving in the army (1914–18) he produced a series of dramatic wartime paintings in which his personal style of probing realism began to emerge. After World War I he studied at the Dresden Academy (1919–21) and the Düsseldorf Academy (1922–25). He lived in Berlin from 1925 to 1927, when he was invited to teach at the Dresden Academy. In 1931 he was elected to the Prussian Academy.

In his paintings Dix used an expressionistic distortion of space and an exaggerated realism to accost the viewer with hideous despairing images of humanity—most often prostitutes, alcoholics, beggars, and grotesque amputees, as in *Prague Street* (1920; Galerie der Stadt, Stuttgart). His work, done in the DADA spirit of protest, linked him with George GROSZ. Both artists were charged by the Nazis with obscenity because of their shocking images of the degradation of the human spirit. In 1933 the regime stripped Dix of his professional positions and a year later banned him from exhibiting. His works were included in the Degenerate Art Exhibition (1937), and he was arrested (1939) for alleged participation in a plot against Hitler. In 1945 he was nonetheless drafted into the army and later interned by the French. His late works are mystical in feeling and content.

Portrait of a Journalist *(Sylvia von Harden) was painted by the German satirist Otto Dix in 1926. Using distorted realism, Dix portrays the characteristics of his subject with biting directness and wit. (Musée National d'Art Moderne, Paris.)*



Dixiecrats The Dixiecrats were a group of Southern Democrats who broke away from the Democratic National party in 1948 after its national convention adopted a plank favoring civil rights legislation. They chose Gov. Strom THURMOND of South Carolina as their presidential candidate, hoping to prevent either the Democratic candidate, President Harry S. TRUMAN, or his Republican opponent, Thomas E. DEWEY, from receiving a majority of the electoral votes. They failed in their strategy, winning only 39 electoral votes and 22.5 percent of the popular vote in the South.

Dixieland see JAZZ

Djibouti (city) [jee-boo'-tee] Djibouti is the capital and only urban center of the Republic of Djibouti. The population is 220,000 (1987 est.). It is located on the Gulf of Tadjoura, just south of Bab el-Mandeb, the entrance to the Red Sea. This strategically located port was founded by the French in 1888.

Djibouti (country) Djibouti is a tiny republic situated just north of the Horn of Africa, on the strait of Bab el-Mandeb, the gateway to the Red Sea. Bordered by Ethiopia and Somalia, Djibouti has been adversely affected by regional tensions. In particular, the presence of large numbers of refugees from the Ogaden region of Ethiopia has imposed a severe economic burden on this already impoverished nation. Formerly known as the French Territory of the Afars and the Issas, the country became independent in 1977.

AT A GLANCE

REPUBLIC OF DJIBOUTI

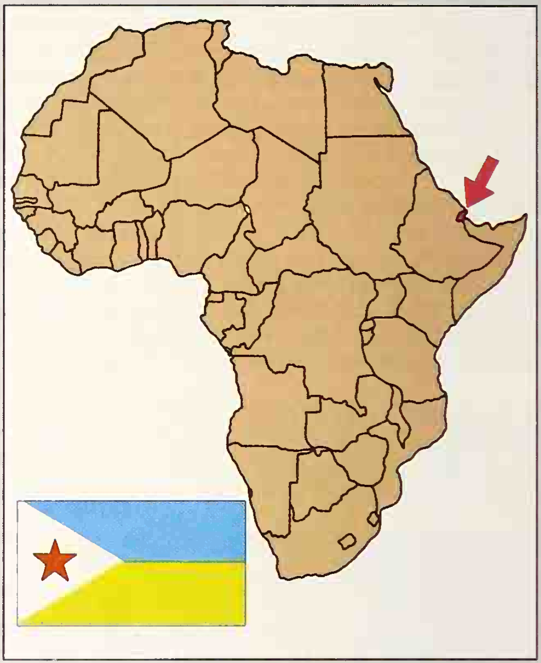
Land: Area: 23,200 km^2 (8,958 mi^2). Capital and largest city: Djibouti (1987 est. pop., 220,000).

People: Population (1990 est.): 337,386. Density (1989 est.): 14.5 persons per km^2 (37.7 per mi^2). Distribution (1989 est.): 74% urban, 26% rural. Official language: French. Major religion: Islam.

Government: Type: one-party republic. Legislature: Chamber of Deputies. Political subdivisions: 5 districts.

Economy: GNP (1986): $333 million; $1,070 per capita. Labor distribution (1985): agriculture—78%; manufacturing, construction, public utilities—7%; trade, finance, government, and services—15%. Foreign trade (1986): imports—$198 million; exports—$128 million. Currency: 1 Djiboutian franc = 100 centimes.

Education and Health: Literacy (1987): 34% of adult population. Universities (1990): none. Hospital beds (1987): 1,185. Physicians (1987): 89. Life expectancy (1990): women—49; men—45. Infant mortality (1990): 119 per 1,000 live births.



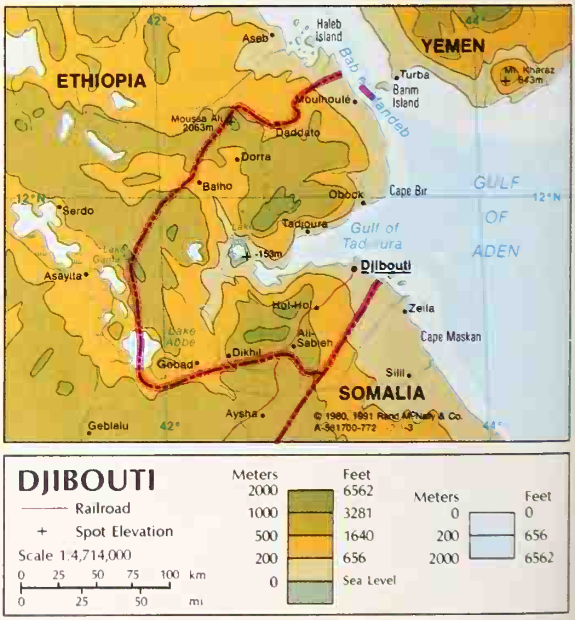
Land

Nearly 90% of Djibouti is volcanic desert. Minor mountain ranges extend from the coastal plain to the Ethiopian highlands, where Moussa Ali, the highest point in the country, rises to 2,063 m (6,768 ft). The long coastline is deeply indented by the Gulf of Tadjoura. Djibouti is one of the hottest places on Earth, with an average annual temperature of nearly 32° C (90° F). The average annual rainfall is less than 125 mm (5 in), and vegetation is sparse. Salt extracted from the sea is Djibouti's major resource.

People and Economy

The population is roughly divided between two groups: the Afars of the north and the Somali-speaking Issas of the south. Both are Muslim, and both were traditionally pastoral nomads who roamed large areas without regard for political boundaries. The Afars, who lean politically toward Ethiopia, and the Issas, with traditional affinity to Somalia, have often fought fiercely. Educational and health facilities are limited, and literacy is low.

The capital city and port of Djibouti, which is also the terminus of the Djibouti-Ethiopian Railroad (completed 1917), provides much of the national revenue, and the service sector, especially banking, is being expanded. Less than 10% of the land is permanent pastureland



where nomads graze their cattle, sheep, and goats. Date palms are grown on the small amount of irrigated land; there is also a small fishing industry. Almost all consumer goods must be imported, and the economy is heavily dependent on foreign aid.

Government and History

Djibouti is a one-party state headed by an elected president who appoints the prime minister. The unicameral parliament is directly elected from a single list.

France took possession of Djibouti (called French Somalia) in 1884. As the Territory of the Afars and the Issas, it remained part of the French republic until 1977, when it gained independence despite conflicting Ethiopian and Somali claims. Hassan Gouled Aption, Djibouti's first president, was reelected in 1981 and 1987. Since independence Djibouti has attempted to remain neutral in the conflicts between and within Ethiopia and Somalia. It has received substantial foreign aid because of its strategic location.

Djilas, Milovan [jee'-lahs, mee'-luh-vahn] Milovan Djilas, b. June 12, 1911, is a Yugoslav Communist leader who broke with the Communist system. He was prominent in the Yugoslav partisan resistance against Germany during World War II and held high posts in the Communist party and government after 1945. He backed TITO in the latter's break (1948) with Moscow and devised the ideological underpinnings for Tito's brand of National Communism. In 1954, however, he was expelled from the government for demanding more freedom at home; two years later he was imprisoned for praising the Hungarian Revolution. In *The New Class,* published abroad in 1957, Djilas argued that the Communists have created an oppressive state capitalism benefiting only a privileged class of bureaucrats. Freed for one year, Djilas was rearrested in 1962 after publication of his revealing *Conversations with Stalin*; he was released again in 1966.

Dmowski, Roman [dmawf'-skee, roh'-mahn] Roman Dmowski, b. Aug. 9, 1864, d. Jan. 2, 1939, was a Polish statesman who played a decisive part in the restoration of Poland's political independence and territorial unity after World War I. In 1917 he formed in Switzerland the Polish National Committee, which the allies later recognized as the official representative of Polish interests. In January 1919 the government of restored Poland, headed by Józef PIŁSUDSKI, appointed Dmowski first delegate at the PARIS PEACE CONFERENCE. He was a member (1920–22) of the constituent *Sejm* (national assembly), and in 1923 he was foreign minister.

DNA see GENE

Dnepr River [nee'-pur or duh-nyep'-ur] The Dnepr River, the third longest river in Europe, is located in the western USSR. It is 2,255 km (1,400 mi) long, from its source in the Valdai Hills west of Moscow to its swampy, delta mouth at the Black Sea. Its course takes it generally south and west past Smolensk, Kiev, Dnepropetrovsk, and Kherson. Draining a basin that covers 505,000 km^2 (195,000 mi^2), the main tributaries of the Dnepr include the Berezina, Pripyat, Sozh, Ingulets, and Desna rivers. Dredging and damming have made almost the entire river navigable for the 9 months of the year when it is not frozen. The Dnepr carries heavy freight and is an important source of hydroelectric power.

Dnepropetrovsk [duh-nyep'-ruh-pet-rawfsk'] Dnepropetrovsk is the capital of Dnepropetrovsk oblast in the Ukrainian republic of the USSR. The city's population is 1,179,000 (1989). The city center is on the high right bank of the Dnepr River, with industrial suburbs across the river on the lower left bank. A major industrial center and transport hub, Dnepropetrovsk produces steel pipes, wheels, structural steel, metallurgical equipment, and a wide range of other types of machinery. The city is also an educational center, with a university and several specialized engineering schools.

Founded in the 1780s during the Russians' southward advance against the Turks, it was first named Yekaterinoslav in honor of Catherine II. It was renamed Dnepropetrovsk in 1926, when the names of the Dnepr River and of G. I. Petrovsky, a Ukrainian Bolshevik leader, were combined. Dnepropetrovsk was occupied by the Germans from 1941 to 1943.

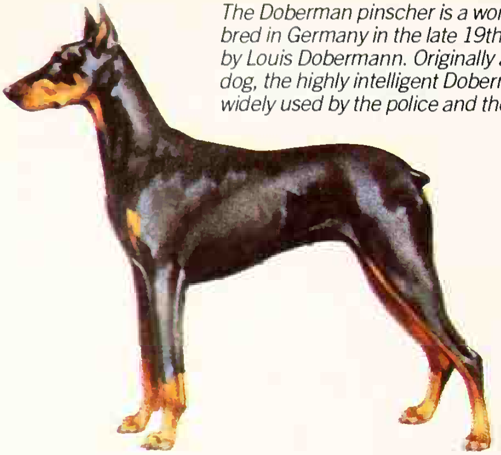
Dnestr River [duhn-yes'-tur] The Dnestr River has a meandering course of 1,350 km (839 mi) through the southwestern USSR, from the Carpathian Mountains southeast to the Black Sea near Odessa. With its tributaries, which include the Seret and Stry rivers, it drains a basin of 72,500 km^2 (28,000 mi^2). Its undependable water level makes it unsuitable for large-scale navigation, however. The river is frozen from November to January each year.

Dnieper River see DNEPR RIVER

Dniester River see DNESTR RIVER

Doberman pinscher [doh'bur-muhn] The Doberman pinscher is a smooth-coated, usually black dog, with reddish tan markings on the face, chest, and feet, although reddish, bluish, or fawn coats also occur. In the United States, the Doberman pinscher's hanging ears are cropped to stand erect and the tail is docked to make it short. Males stand 66 to 71 cm (26 to 28 in) high at the shoulder, and females 61 to 66 cm (24 to 26 in); the weight ranges from 27 to 34 kg (60 to 75 lb).

The breed is named for Louis Dobermann, of Germany, who is generally credited with originating the breed



The Doberman pinscher is a working dog bred in Germany in the late 19th century by Louis Dobermann. Originally a guard dog, the highly intelligent Doberman is widely used by the police and the military.

when he crossbred (*c.*1890) the Rottweiler, pinscher, terrier, and possibly other dogs. Because of its outstanding ability as a guard dog, the Doberman has grown steadily in popularity.

Döblin, Alfred [dur'-blin] The German writer Alfred Döblin, b. Aug. 10, 1878, d. June 28, 1957, was a Berlin psychiatrist who won early fame as an expressionist writer and cofounder of the magazine *Der Sturm* in 1910. He wrote under the pseudonym Linke Poot and is best known for the novellas in *Die Ermordung einer Butterblume* (Murder of a Buttercup, 1913) and the experimental novel *Berlin Alexanderplatz* (1929; Eng. trans., 1931, 1958), in which he is indebted to James Joyce's *Ulysses*. Döblin fled (1933) Nazi Germany, became a French citizen, and converted to Catholicism. He returned to Germany after the war as a cultural attaché of the French army and died near Freiburg, dejected at the apparent failure of his later writings. Many of these, such as his novel *Tales of a Long Night* (1946; Eng. trans., 1984), later attracted attention.

Dobruja [doh'-bru-jah] Dobruja (Romanian: Dobrogea) is a historical region lying between the lower Danube River and the Black Sea. It is now partitioned between Romania and Bulgaria. Thracians entered the area during the 5th century BC but were, in turn, conquered by the Scythians in the same century. The Romans occupied the territory from 75 BC. The Byzantines succeeded the Romans, but in the last quarter of the 7th century AD the Bulgars, a people from the Russian steppes, overran Dobruja. After the destruction of the Bulgarian Empire, Dobruja came under Ottoman Turkish domination in 1417. This lasted until 1878, when the Congress of Berlin assigned the northern part of the province to Romania. After the BALKAN WARS of 1912–13, Romania secured from Bulgaria the southern part of Dobruja. On Sept. 7, 1940, under German and Italian pressure, Romania returned southern Dobruja to Bulgaria.

Dobzhansky, Theodosius [dawb-zhahn'-skee, thee-oh-doh'-zee-uhs] Theodosius Dobzhansky, b. Jan. 25, 1900, d. Dec. 18, 1975, a Russian-American biologist and pioneering geneticist, through detailed studies of *Drosophila,* or fruit flies, made important discoveries applicable to all fields of genetics. Dobzhansky found that great genetic diversity exists within a species, including a "genetic load" of less useful and weakening genes. The greater the genetic load, the greater the diversity, therefore the greater probability that at least some individuals in a species can adapt to changing environmental conditions and thus be naturally selected through the processes of evolution. Dobzhansky's major writings are *Genetics and the Origin of Species* (1937), a summation of modern genetics, and *Mankind Evolving: The Evolution of the Human Species* (1962), which deals with biological and cultural evolution.

Docetism [doh-seet'-izm] Docetism is a belief of some early Christians concerning the person of Jesus Christ. The word is derived from the Greek *dokeo,* meaning "to seem" or "to appear." According to Docetism, the eternal Son of God did not really become human or suffer on the cross; he only appeared to do so. This teaching, rejected as a heresy by the main body of the church, was based on a DUALISM that held that the material world is either unreal or evil. Tendencies to spiritualize Christ by denying his real humanity began in New Testament times. Docetic teachings were also advanced by the 2d-century proponents of GNOSTICISM and were combated by the 2d-century church fathers, especially by IGNATIUS OF ANTIOCH and IRENAEUS.

Doctor Faustus see FAUST

Dr. Jekyll and Mr. Hyde [jek'-ul] The idea for *The Strange Case of Dr. Jekyll and Mr. Hyde* (1886) came to its author, Robert Louis STEVENSON, in a dream. The story emerges from the inquiries of a lawyer, Mr. Utterson, who finds that a respectable physician, Dr. Jekyll, can chemically transform himself into a lascivious, unscrupulous alter ego. This is Mr. Hyde, the embodiment of Dr. Jekyll's "lower nature." Jekyll is fatally attracted to his alter ego, and eventually Hyde wins control. Fear of discovery finally leads to Jekyll's suicide. The personality division suggests Sigmund Freud's id and superego and their inevitable conflict. Many film adaptations of the work have appeared since 1920.

Doctor Zhivago see PASTERNAK, BORIS

Doctorow, E. L. [dahk'-tur-oh] Edgar Lawrence Doctorow, b. New York City, Jan. 6, 1931, a contemporary American novelist, blends fiction with reinvented history. His first novel was the Western *Welcome to Hard Times* (1960; film, 1967). *The Book of Daniel* (1971;

E. L. Doctorow, an American writer of popular fiction, won critical acclaim in 1971 with a major historical novel, The Book of Daniel. *Other historical novels include* Ragtime *(1975),* World's Fair *(1985), and* Billy Bathgate *(1989).*

filmed as *Daniel*, 1983) concerns a young man whose parents have been executed for selling atomic secrets and draws somewhat from the Julius and Ethel Rosenberg case. *Ragtime* (1975; film, 1981) blends fact, fiction, and "fictitious facts" in pre–World War I America. Doctorow explores aspects of the 1930s in later novels: a millionaire's life (*Loon Lake*, 1980); a memoir of growing up in the Bronx (*World's Fair*, 1985; National Book Award); and *Billy Bathgate* (1989), another Bronx-based book, whose hero works for mobster Dutch Schultz.

Doctors of the Church During the Middle Ages, eight great Christian theologians were recognized as Doctors of the Church because of their orthodoxy of doctrine and holiness of life: saints Ambrose, Athanasius, Augustine, Basil the Great, John Chrysostom, (Pope) Gregory I, Gregory of Nazianzus, and Jerome. In later times, others were added to the list by the Roman Catholic church.

documentary The greatest myth surrounding the documentary film is that it depicts absolute truths. A more precise term would be the nonfiction film. Documentaries are often carefully scripted and structured, and despite their reliance on nonprofessional actors, spontaneous dialogue, and concealed cameras, they express a distinct albeit subtle point of view.

Robert Flaherty's *Nanook of the North* (1922), about the Eskimo's vanishing way of life, was the first major documentary. In the USSR Sergei Eisenstein (*October*, 1928), Dziga Vertov (*The Man with the Movie Camera*, 1929), and Alexander Dovzhenko (*Earth*, 1930) made films that were artistically as innovative as they were politically powerful.

In 1928, British film theorist John Grierson was named head of the new Film Unit of the Empire Marketing Board (EMB), charged with making films that would promote a positive image of the British Empire. *Drifters* (1929), *The Song of Ceylon* (1934), and *Night Mail* (1936), among many others, established the documentary as a legitimate film form.

In the United States during the 1930s the great partisan of the documentary was Pare Lorentz, whose *The Plow That Broke the Plains* (1936) and *The River* (1937) were brilliantly shot and scored studies of conditions in the Dust Bowl and the Mississippi Valley.

The 1930s were also witness to the artistry of Leni Riefenstahl, whose *Triumph of the Will* (1935), glorifying the Nazi party as it rallied at Nuremberg in 1934, has been hailed as a masterpiece of propaganda. Her *Olympia* (1938), with its exalted view of athletes, remains a popular film.

After the war, documentary filmmakers experimented with films as unusual as the Canadian *City of Gold* (1957)—about Dawson City, center of the Klondike gold rush of the 1890s—which used late-19th-century still photos so minutely detailed that the camera could range over them as if they were living landscapes. A number of meticulously researched and photographed science films began to appear: the first film by Jacques Yves Cousteau, *The Silent World*, was made in 1956.

Television became the principal medium for the commissioning and showing of documentaries in the United States. Many were subsidized by business. *See It Now* (1951–58), a CBS documentary series sponsored for a time by Alcoa, made a number of films on McCarthyism, written by Edward R. Murrow and Fred Friendly. These were among the last of the politically controversial documentaries made for commercial TV, however. Although public TV continued to buy and show documentaries notable for their subjects (for example, the 13-part series *Vietnam*, 1983), the networks began to refuse to show any documentaries except those they had commissioned, and, with a few notable exceptions such as the 1971 *Selling of the Pentagon*, by Peter Davis, finally gave up their role as a medium for documentaries.

Fiction filmmakers like Luis Buñuel (*Land without Bread*, 1932), Lindsay Anderson (*Thursday's Children*, 1953), and Alain Resnais (*Guernica*, 1950) were attracted by the documentary form. Resnais's *Night and Fog* (1955)

Frederick Wiseman's documentary Welfare, *like all his work, has neither a narrator nor a musical score. Wiseman trusts solely his camera and editing. The viewer has the impression that the scene on the screen is the absolute truth.*

is a sensitive backward look at France under Nazi occupation. Marcel OPHULS's *The Sorrow and the Pity* (1969), *The Memory of Justice* (1976), and *Hotel Terminus* (1988) deal with occupied France and Nazi war crimes.

The introduction of lightweight 16-mm cameras and portable synchronized sound systems gave a new freedom of movement to the documentarist, who for the first time was able to come close to the subject without seeming intrusive. In the United States, cameraman Richard Leacock and Donn A. Pennebaker produced *Monterey Pop* (1968), and Albert Maysles, with his brother David, filmed the now-famous *Salesman* (1969) and *Gimme Shelter* (1970). In Europe the mobility offered by lightweight equipment ushered in cinéma vérité, where the director is seen intruding into the action to elicit truer reactions from the participants. The style has exerted tremendous influence on fiction filmmakers.

Fred WISEMAN's portraits of U.S. institutions (a hospital for the criminally insane, *Titicut Follies*, 1967; a research institute for the study of animals, *Primate*, 1974) are chilling and funny. Perhaps the most extraordinary documentary of recent years is Claude Lanzmann's *Shoah* (1985), a monumental, 9½-hour film about memories of the Holocaust.

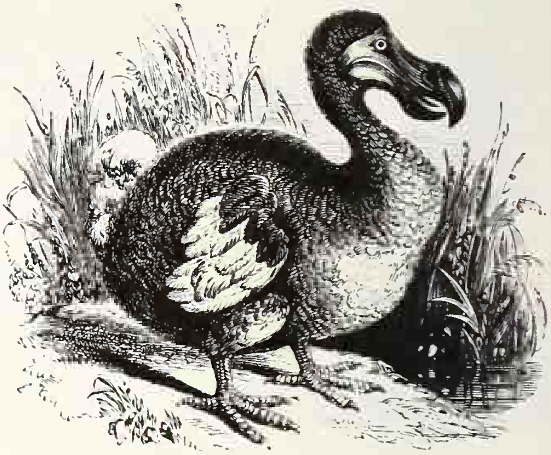
Dodecanese [doh-dek'-uh-neez] The Dodecanese is a group of 14 mountainous Greek islands and several islets in the Aegean Sea. The name means "twelve islands" in Greek and refers to the original number of islands thought to be in the group. The islands cover an area of 2,662 km^2 (1,028 mi^2). The main islands are RHODES, the administrative center; Cos (Kós); Kálimnos; and Karpathos. The principal industries are sponge diving, fishing, farming, and tourism. The population is 145,071 (1981).

The Dodecanese were occupied by Romans, Byzantines, Venetians, Genoese, and the Hospitalers (Knights of St. John). During the Italo-Turkish War of 1912, they were taken by Italy and remained, except for a brief period, under Italian occupation until 1943. In 1947 the Dodecanese were formally reunited with Greece.

Dodge City Dodge City is the seat of Ford County in southwestern Kansas and has a population of 21,129 (1990). Located on the Arkansas River, the city was settled in 1872 and soon became a notorious frontier town and cattle-shipping point on the Santa Fe Trail. Today it is the commercial hub of an agricultural area.

Dodgson, Charles Lutwidge see CARROLL, LEWIS

dodo bird Dodo birds are an extinct family, Raphidae, of three species of stout, flightless birds once found on the Mascarene Islands (Mauritius, Réunion, and Rodriguez), in the Indian Ocean, east of Madagascar. Each species inhabited one of the islands. The dodo of Mauritius, *Raphus cucullatus,* was about the size of a turkey and weighed up to an estimated 23 kg (50 lb). Its wings were rudimentary, but it had strong feet and a heavy, hooked bill. The dodo's plumage was largely ashy blue gray. It was extinct by 1681.



Reconstructions of the extinct dodo bird have been made from early sketches and fossil remains. This 19th-century woodcut is from Richard Lydekker's Natural History.

The Réunion solitaire, *R. solitarius*, was very similar to the dodo of Mauritius but was whitish in color. It was extinct by about 1750. The Rodriguez solitaire, *Pezophaps solitaria,* was about the same size as the others but brownish in color and with a short, unhooked bill. Whitish-colored forms may have existed as well. This species was extinct by about 1800.

It has been theorized that the dodo birds inhabited the Mascarene Islands for thousands of years before they were discovered about 1507 by the Portuguese. During that time, in the absence of natural enemies, the dodos, which are related to pigeons, order Columbiformes, evolved into their stocky, flightless forms and were unadapted to coping with predators.

Dodson, Owen Owen Dodson, b. Brooklyn, N.Y., Nov. 28, 1914, d. June 21, 1983, was an African-American poet, playwright, and novelist. His poetry includes *Powerful Long Ladder* (1946) and *The Confession Stone* (1970). Dodson's major energies, however, went into writing and teaching drama. Among his plays are *Divine Comedy* (1938), *The Garden of Time* (1939), *Bayou Legend* (1946), *Media in Africa* (1964), and *The Dream Awake,* a dramatic poem. His novel *Boy at the Window* (1951) was praised for the realism of its portrait of a nine-year-old Brooklyn boy suddenly forced to cope with the demands of adulthood.

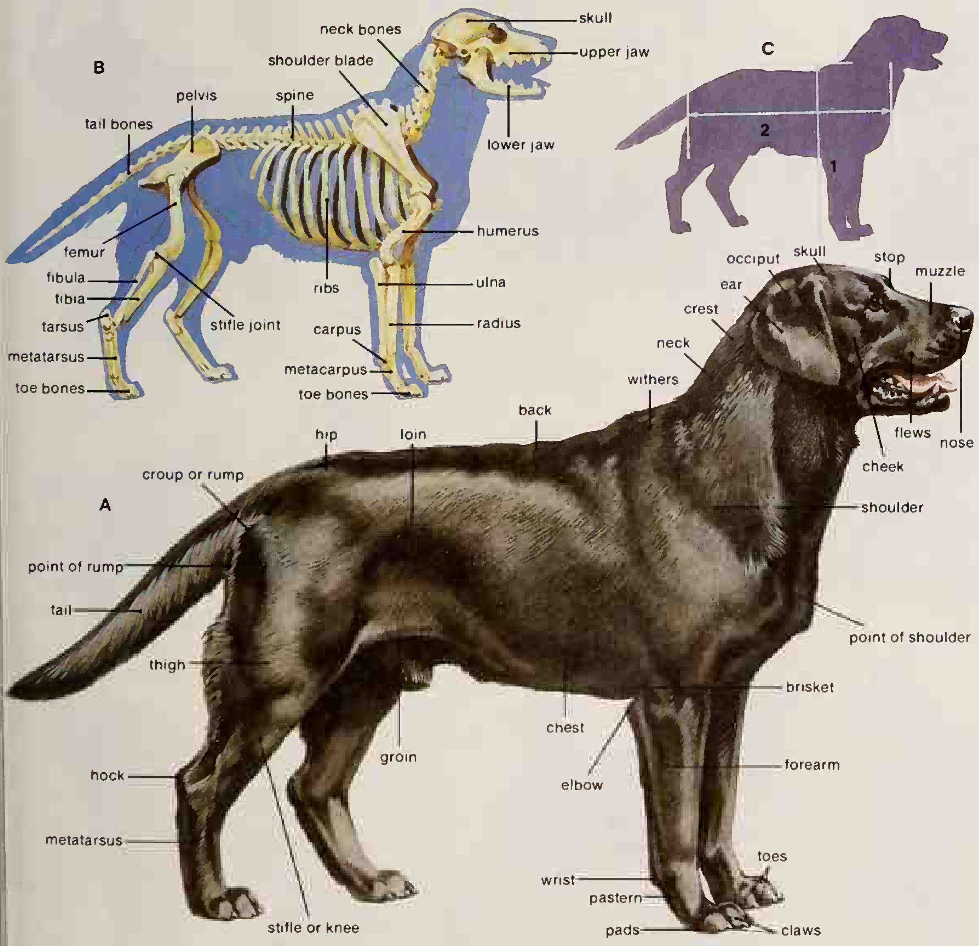
Doe, John or Jane John and Jane Doe, also Richard and Jane Roe, are fictitious names used to identify parties in legal actions when their actual names are not known or they do not wish them to be revealed. See, for example, Roe v. Wade and Doe v. Bolton. Recently, Baby Doe has been used in cases involving questions of medical care for severely handicapped newborns.

Doe, Samuel K. Master sergeant Samuel Kenyon Doe, b. May 6, 1951, d. Sept. 9, 1990, led a 1980 coup against William R. Tolbert, Jr., to become the first Liberian head of state descended from the region's original inhabitants. Doe, who promoted himself to general in 1981, dissolved his ruling military council in 1985 and became president of a civilian government. As civil war engulfed Liberia, he was killed by rebel forces.

Doenitz, Karl [dur'-nits] A German admiral, Karl Doenitz, b. Sept. 16, 1891, d. Dec. 24, 1980, succeeded (May 1, 1945) Adolf Hitler as leader of Nazi Germany and surrendered to the Allies on May 7, 1945, thus ending World War II in Europe. He commanded the German submarine force until Jan. 30, 1943, when Hitler made him commander in chief of the navy. Hitler designated Doenitz as his successor just before his death. The admiral received a 10-year prison sentence at the Nuremberg Trials. Released in 1956, he published his *Memoirs* in 1958 (Eng. trans., 1959).

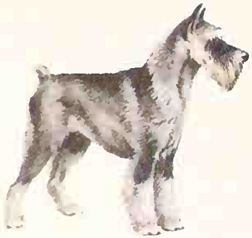
Doesburg, Theo van [doos'-burg] Theo van Doesburg, b. Aug. 30, 1883, d. Mar. 7, 1931, was an influential Dutch painter, teacher, and theorist, originally named Christian Curil Marie Küpper. In 1915, van Doesburg met Piet Mondrian, with whom he helped form the de Stijl group, an influential abstractionist circle; he then taught at the Bauhaus in Weimar. Van Doesburg called his own theory of painting Elementarism, a system asserting that the basic elements of painting are lines and shapes. His paintings reflect this theory in their firm avoidance of any representational reference, as in *Card Players* (1917; Gemeente Museum, The Hague, Netherlands).

dog The dog, *Canis familiaris*, of the dog family, Canidae, is thought to have descended from a wolflike crea-

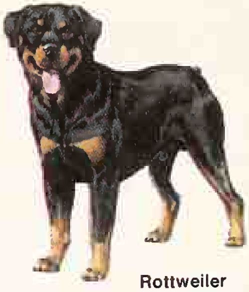


The external anatomical features of a dog are indicated in this illustration of a Labrador retriever (A). *No matter what the size or conformation, all dogs have a similar skeletal structure* (B). *Although the number of bones is always the same, their size and shape vary with the breed. The Labrador has heavy bones and rounded ribs, while slender dogs like the whippet have long, thin leg bones and sloping ribs. A dog's shoulder height* (C) *is measured vertically from the withers, or highest point of the shoulders, to the ground* (1). *Length is the measurement from the point of shoulder to the point of rump* (2).

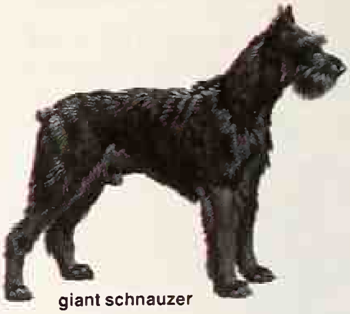
Working Group



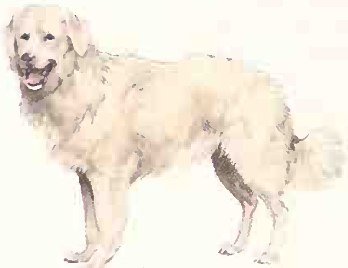
standard schnauzer



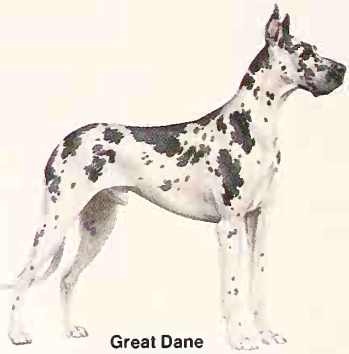
Rottweiler



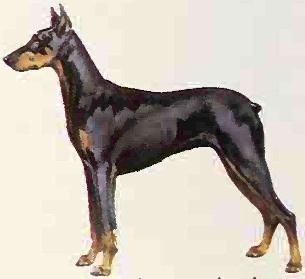
giant schnauzer



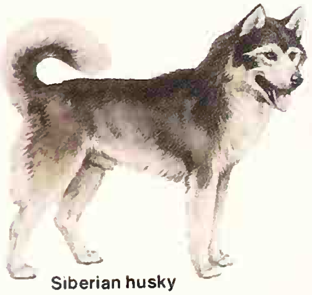
kuvasz



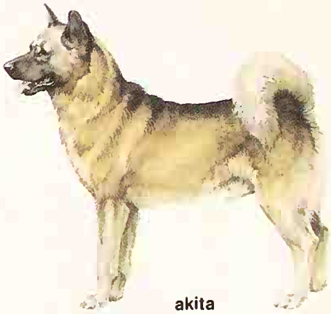
Great Dane



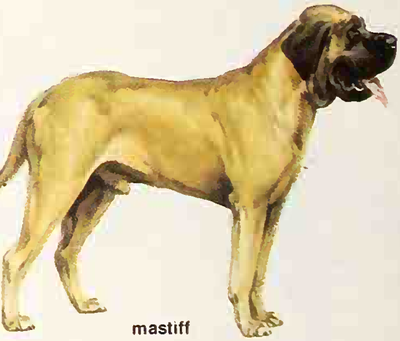
Doberman pinscher



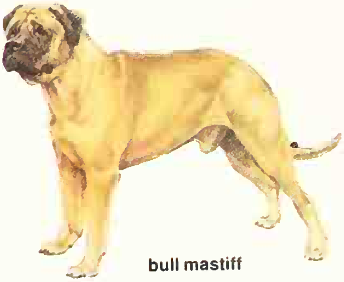
Siberian husky



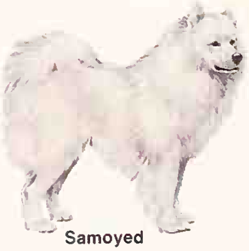
akita



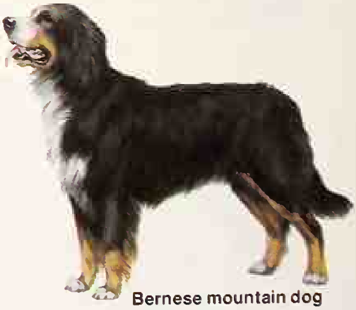
mastiff



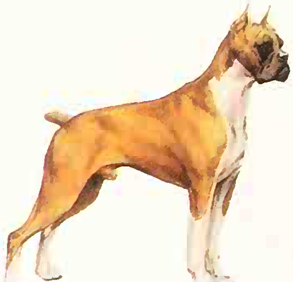
bull mastiff



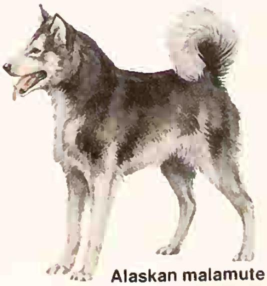
Samoyed



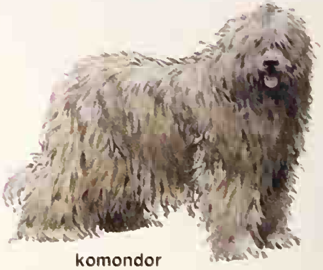
Bernese mountain dog



boxer

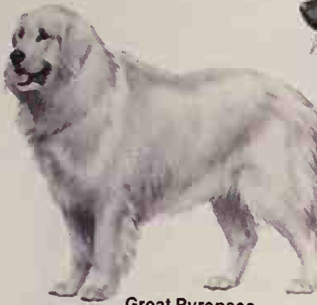


Alaskan malamute

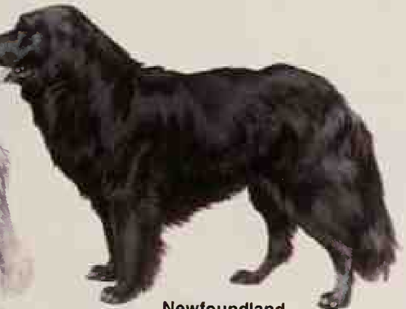


komondor

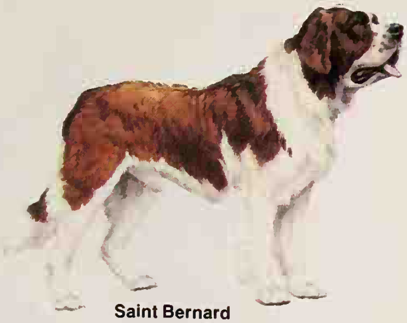
Working Group



Great Pyrenees

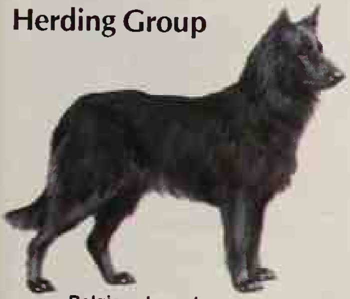


Newfoundland

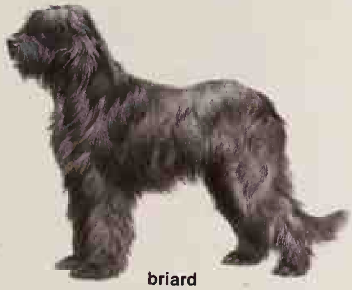


Saint Bernard

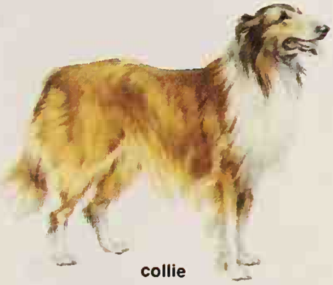
Herding Group



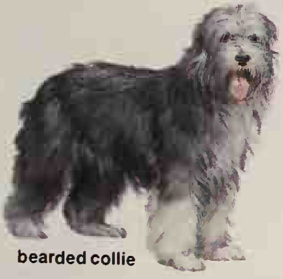
Belgian sheepdog



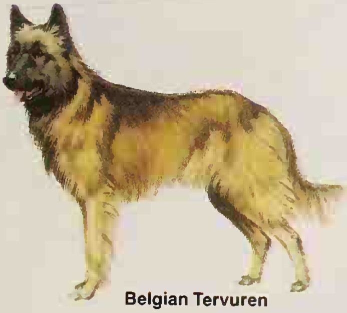
briard



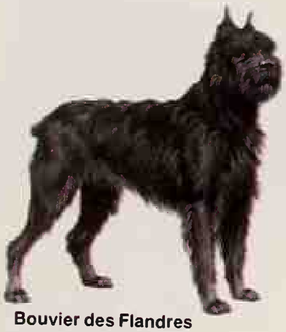
collie



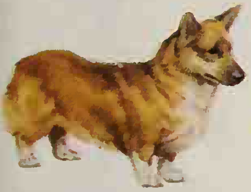
bearded collie



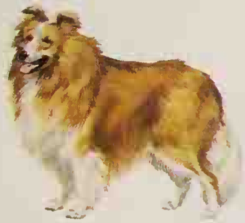
Belgian Tervuren



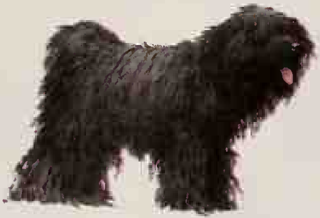
Bouvier des Flandres



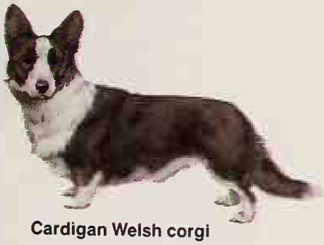
Pembroke Welsh corgi



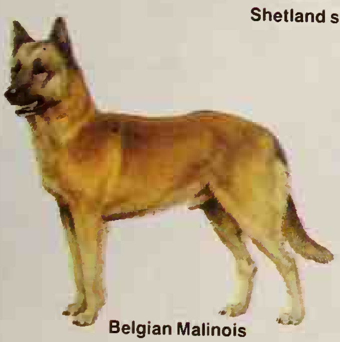
Shetland sheepdog



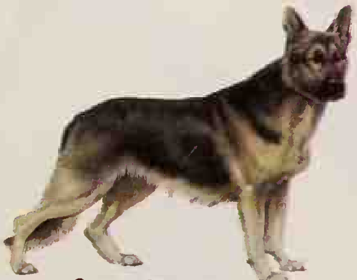
puli



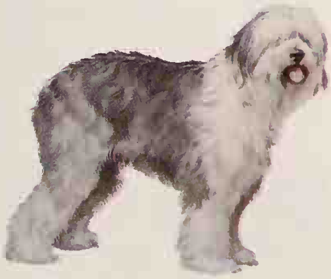
Cardigan Welsh corgi



Belgian Malinois

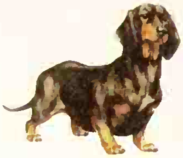


German Shepherd

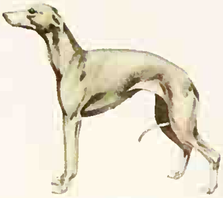


Old English sheepdog

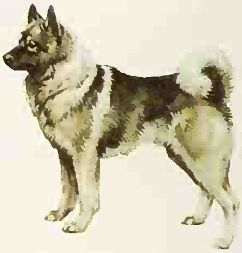
Hound Group



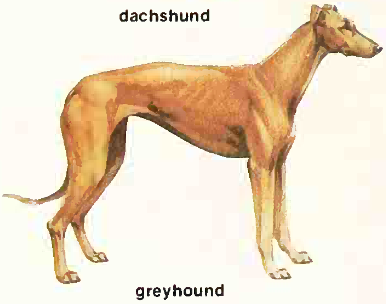
dachshund



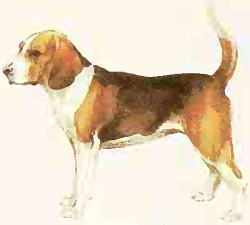
whippet



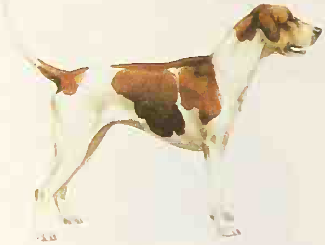
Norwegian elkhound



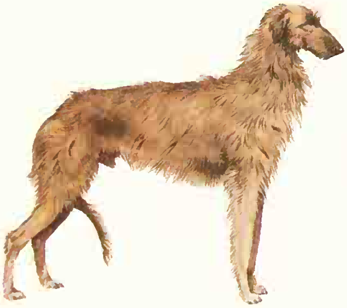
greyhound



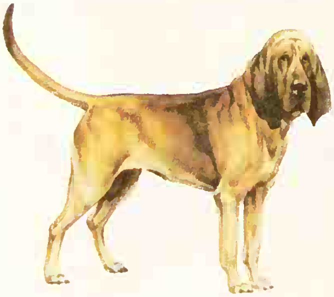
beagle



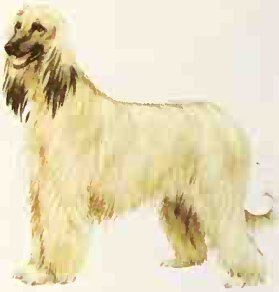
English foxhound



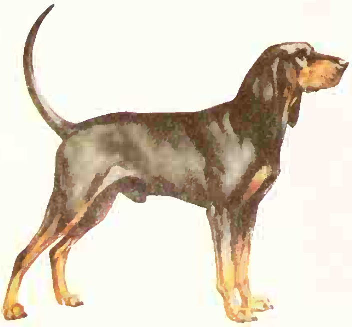
Scottish deerhound



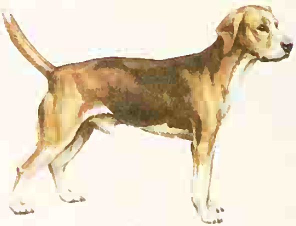
bloodhound



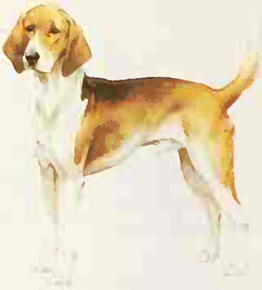
Afghan hound



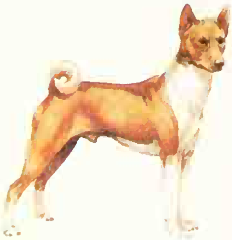
black-and-tan coonhound



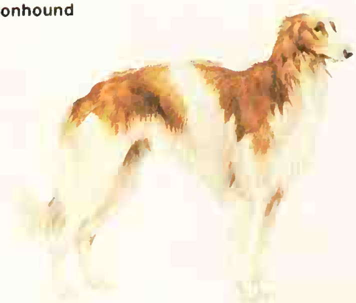
harrier



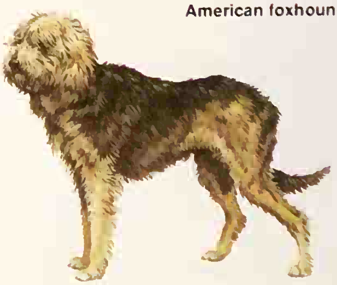
American foxhound



basenji

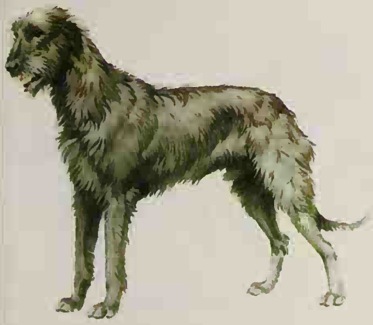


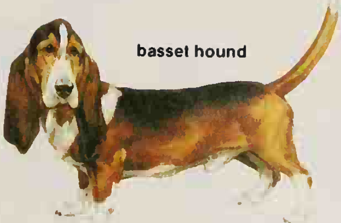
borzoi

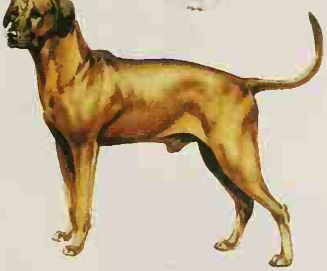


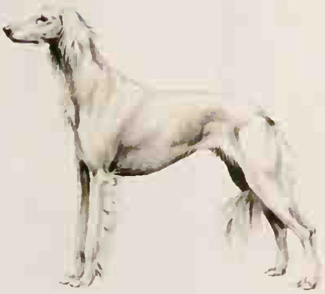
otter hound

Hound Group

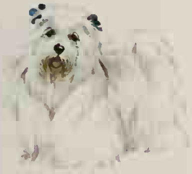

Irish wolfhound

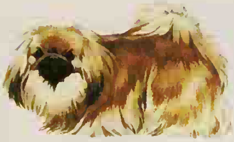

basset hound

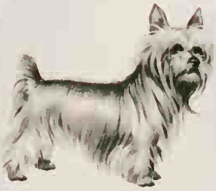

Rhodesian ridgeback

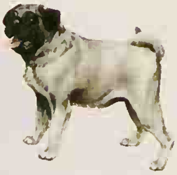

saluki

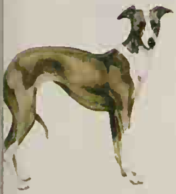
Toy Group

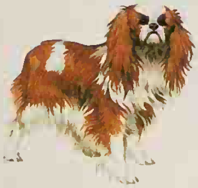

Maltese

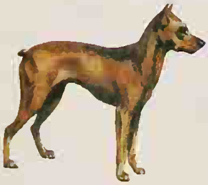

Pekingese

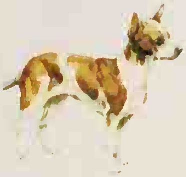

silky terrier

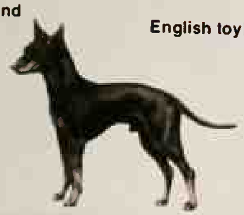

pug

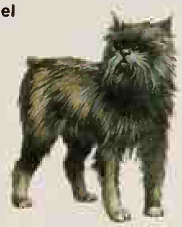

Italian greyhound

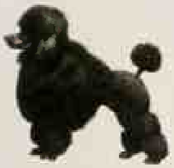

English toy spaniel

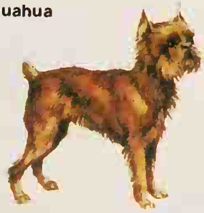

miniature pinscher

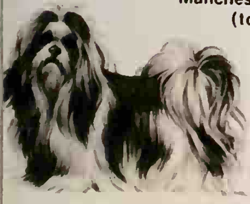

Chihuahua

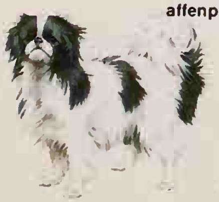

Manchester terrier
(toy)

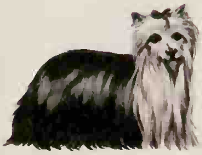

affenpinscher

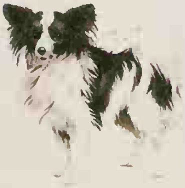

toy poodle

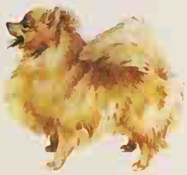

Brussels griffon


shih tzu

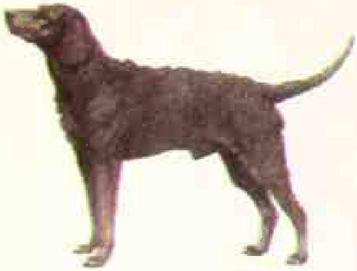

Japanese spaniel


Yorkshire terrier

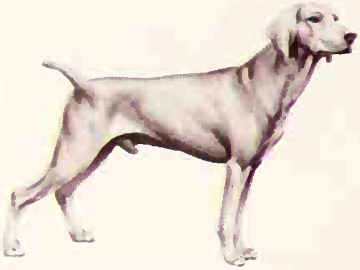

papillon


pomeranian

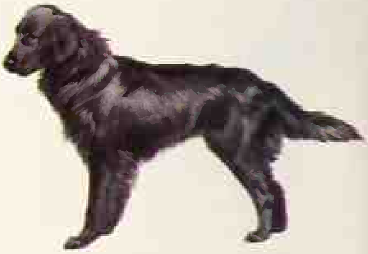
Sporting Group



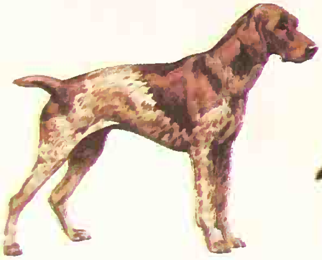
curly-coated retriever



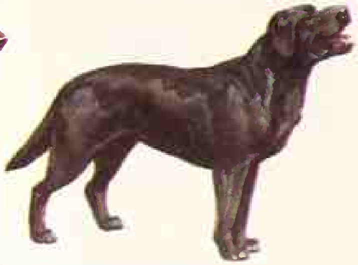
Weimaraner



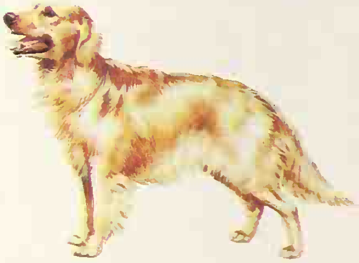
flat-coated retriever



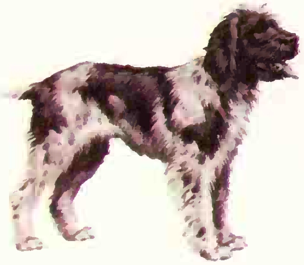
German shorthaired pointer



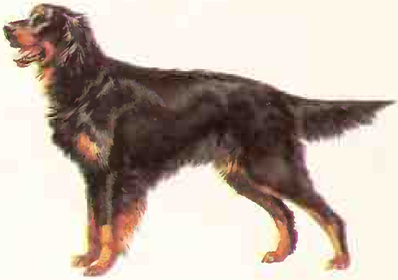
Labrador retriever



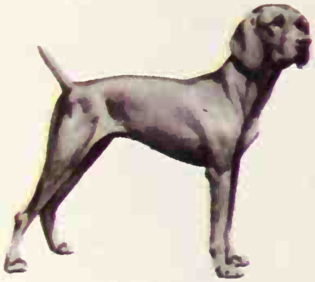
golden retriever



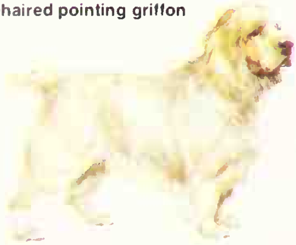
wirehaired pointing griffon



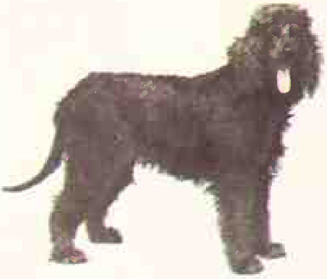
Gordon setter



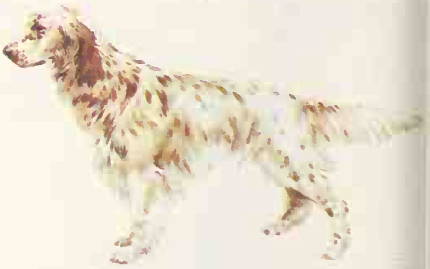
Vizsla



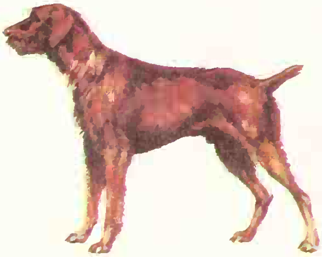
Clumber spaniel



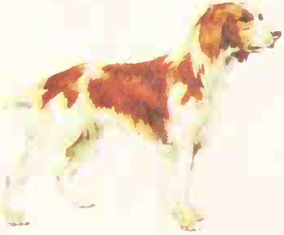
Irish water spaniel



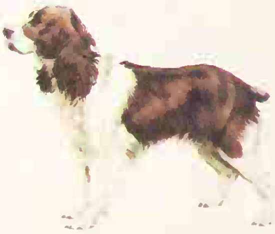
English setter



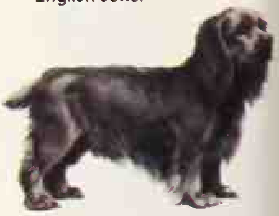
German wirehaired pointer



Brittany spaniel

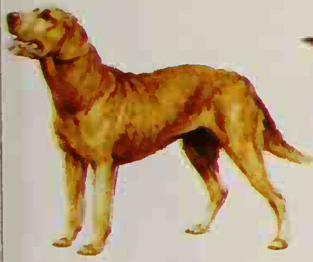


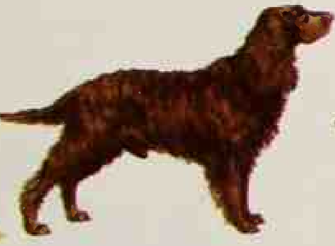
English springer spaniel

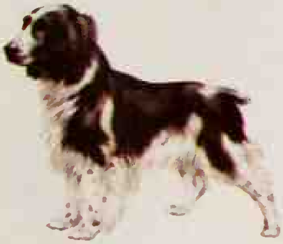


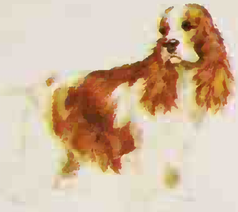
Sussex spaniel

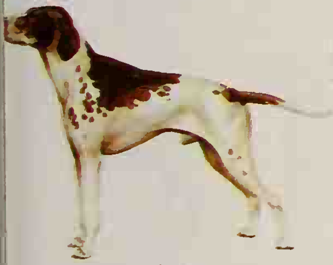
Sporting Group

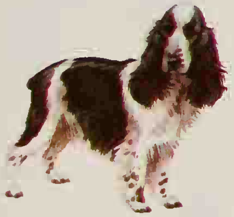

Chesapeake Bay retriever

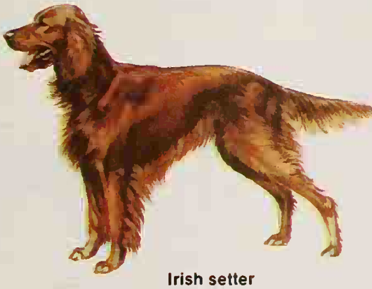

American water spaniel

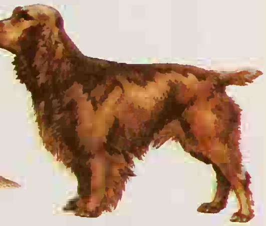

Welsh springer spaniel


cocker spaniel

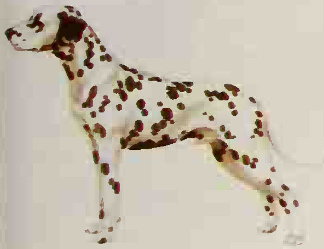

pointer

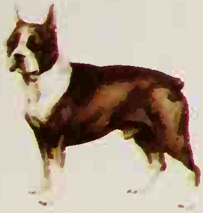

English cocker spaniel

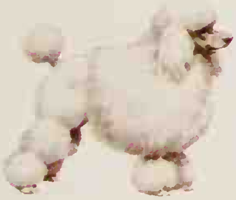

Irish setter

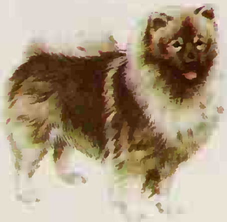

field spaniel

Nonsporting Group


Dalmatian


Boston terrier


miniature poodle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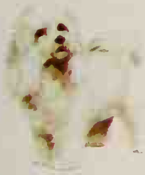
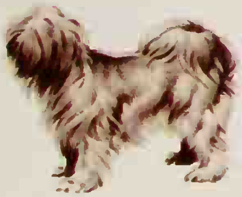
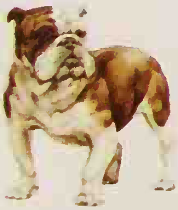
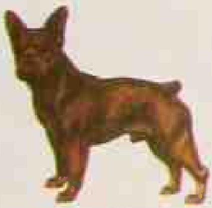
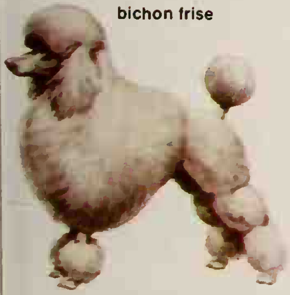
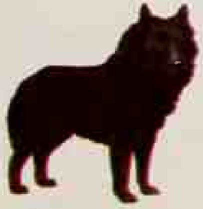

bichon frise

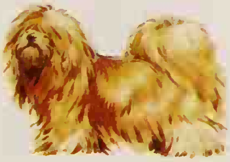

Tibetan terrier

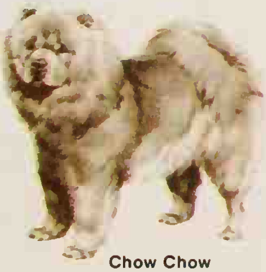

bulldog


French bulldog

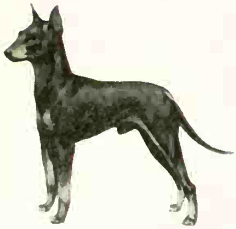

standard poodle


schipperke

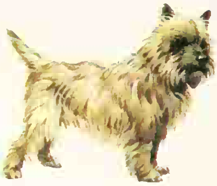

Lhasa apso


Chow Chow

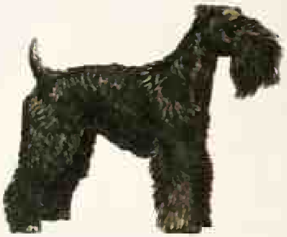
Terrier Group



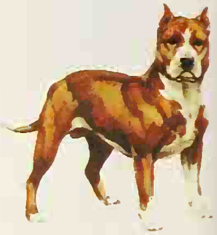
Manchester terrier



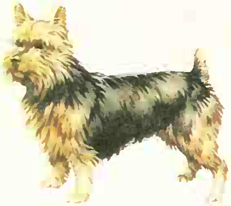
cairn terrier



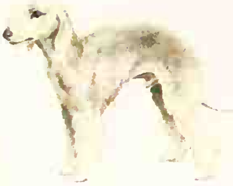
Kerry blue terrier



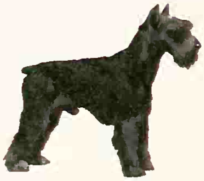
American Staffordshire terrier



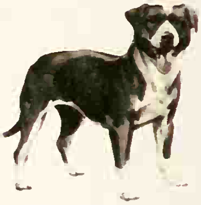
Australian terrier



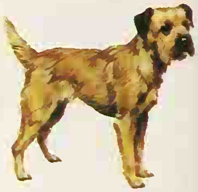
Bedlington terrier



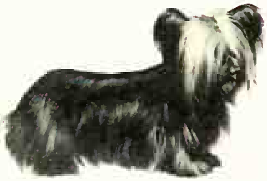
Miniature schnauzer



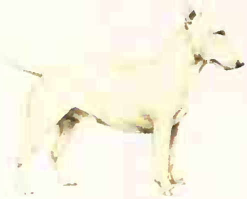
Staffordshire bull terrier



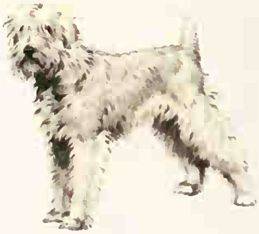
border terrier



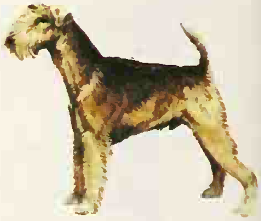
Skye terrier



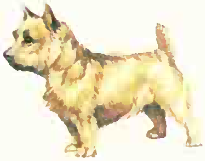
bull terrier



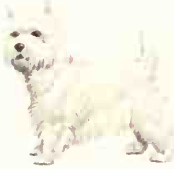
soft-coated Wheaten terrier



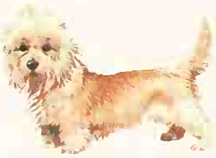
Lakeland terrier



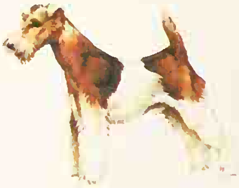
Norwich terrier



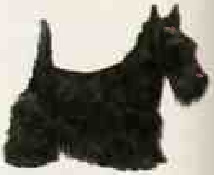
West Highland white terrier



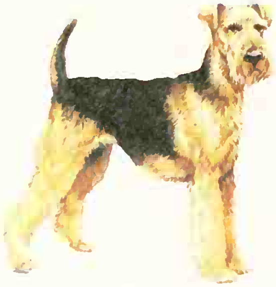
Dandie Dinmont terrier



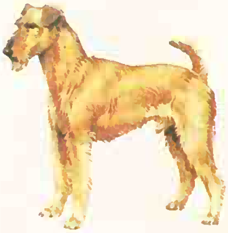
fox terrier



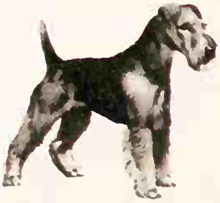
Scottish terrier



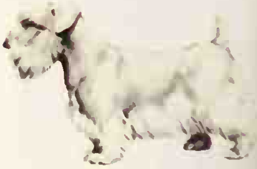
Airedale terrier



Irish terrier



Welsh terrier



Sealyham terrier

ture that lived several million years ago. History suggests that the dog was one of the earliest of domesticated animals, having lived in close association with humans for approximately 10,000 years. No direct evidence exists to support a theory concerning the origin of the human-dog relationship. Because dogs often tend to be scavengers, it has been suggested that they adopted humans rather than the other way around.

Breeds

Although dogs have variable genetically based features, and members of a single litter may be born with marked diversity, the variation in size, shape, and color of domesticated dogs is almost entirely the result of artificial breeding and selection. The American Kennel Club recognizes 130 breeds, grouping them as sporting dogs (pointers, setters, retrievers), hounds (bassets, bloodhounds, foxhounds), working dogs (boxers, malamutes, schnauzers), terriers (bull, fox, Scottish), toys (Chihuahuas, pugs, pomeranians), nonsporting dogs (bulldogs, dalmatians), and herding dogs (collies, sheepdogs, corgis). The American Kennel Club registers more than 1.2 million purebred puppies per year. In a recent year the poodle and the cocker spaniel ranked highest in numbers of puppies registered. Mixed-breed dogs are not eligible for registry. The British Kennel Club lists about 170 breeds; the Fédération Cynologique Internationale, with 65 member countries, lists 335 breeds. In the United States the number of dogs, both purebred and mixed breed, is variously estimated to range up to 50 million.

Usefulness

The dog has been bred for many domestic purposes other than as a pet. Keen senses of hearing and smell have made dogs valuable in hunting and tracking and for guard, security, and search purposes. Dogs also herd livestock and serve as guide dogs for the blind, as sled dogs, and as racing dogs. Their positive effect on people is well documented; they have been used in programs for treating the mentally ill.

Characteristics

Dogs vary more in outward appearance than in anatomical structure. An adult dog may weigh 2 to 99 kg (4 to 220 lb), depending on the breed, and range in height from 12.5 to 90 cm (5 to 35 in) at the shoulder. Other differences in conformation include length of leg; length of muzzle; size and attitude of ears; length, shape, and carriage of tail; and length, density, color, and character of hair.

The female, or bitch, reaches reproductive maturity between 7 and 18 months of age. The gestation period averages 62 to 63 days. An average litter consists of 3 to 6 puppies. Sightless at birth, puppies do not open their eyes until about the tenth day. They are generally weaned by the sixth week. A dog is full grown at the end of the second year, is old at 12, and seldom lives beyond the age of 20.

Dogs have long been mistakenly considered colorblind. While they are unable to differentiate colors ranging from greenish yellow through orange to red, recent studies have shown that they can distinguish between colors at opposing ends of the spectrum. A dog's most important sense, however, is that of smell. An adult dog has 42 teeth, including molars. To drink, a dog laps with its tongue. Dogs do not perspire; heat is dissipated through evaporation from the nose and footpads and from the tongue and respiratory tract (panting). The dog has a simple carnivore stomach but eats cooked vegetables and grain as well as meat.

Selection and Care

Before choosing a dog, individuals should consider carefully what kinds of dogs best suit their life-styles. Some breeds tend to be noisier, more active, or better with children than others; some require a great deal of exercise or grooming.

A dog should be checked regularly by a veterinarian to ensure that it remains in good health. Puppies are given a series of inoculations to protect them against a variety of serious infectious diseases; annual boosters are needed to maintain immunity. Dogs also need to be protected against RABIES and checked for intestinal parasites. Another serious internal parasite, heartworm, is transmitted by infected mosquitoes. An oral heartworm preventive should be given daily during mosquito season. The most common external parasites affecting dogs are FLEAS and TICKS. In cases of severe infestation, treatment with sprays and dips may be necessary.

See also: DISEASES, ANIMAL; articles on individual dog breeds.

dog days In the Northern Hemisphere, dog days are the hottest part of summer and extend from about July 3 to August 11. The term originated in the Mediterranean region, where from ancient times during this period the weather was regarded as unhealthy and uncomfortable, dogs were thought to have spells of madness, and Sirius, the dog star, rose simultaneously with the Sun and supposedly added to its heat.

dog family The dog family, Canidae, order Carnivora, contains about 35 species grouped in 14 genera. This family includes the domestic DOG, *Canis familiaris*; the WOLF, *C. lupus*; the DHOLE; 14 species of FOX; and 4 species of JACKAL. Canids are native to most parts of the world, notable exceptions being Australia and such oceanic islands as New Zealand, New Guinea, and Madagascar. The DINGO, *C. dingo*, of Australia and the highland dog, *C. hallstromi*, of New Guinea, are now believed to be descendants of the domestic dog, introduced by early inhabitants. A very adaptable family, canids occupy a wide variety of habitats, ranging from tropical rain forests to cold northern woods, open plains, dry deserts, and icy tundra.

In general, canids are adapted for running. For example, the COYOTE, *C. latrans*, can reach speeds of 65 km/h (40 mph) when chasing prey. Thus, most dogs have long and slender legs, their bodies are muscular and deep chested, and their claws are strong, blunt, and nonretractile. Their usually elongated skull is considered an adaptation for seizing or biting prey on the run. They typically have five toes on each forefoot and four toes on each hind foot. The fifth, or thumb (pollex), is vestigial.

Canids have 42 teeth; exceptions are the bush dog (38), the dhole (40), and the bat-eared fox, *Otocyon* (48). Included among the teeth are long, powerful canines and other teeth adapted for meat cutting, as well as broad-crowned molars suitable for chewing plants.

Canids range in size from the 1.5-kg (3-lb) *Fennecus* to the 80-kg (175-lb) timber wolf. All canids are active throughout the year, with the exception of the raccoon dog, *Nyctereutes*, which hibernates. Breeding generally occurs once a year, with an average gestation period of 62–63 days.

The larger species of canids often travel in packs, in which individuals follow and obey a dominant member. They have a keen sense of smell for use in hunting. Since canids regularly deposit urine on bushes or rocks to define their territory or hunting zones, this distribution of scent is also used to make acquaintance with others of the same species.

Early humans learned to exploit the dog's sense of smell to help in hunting. As humans became familiar with the behavioral and physical characteristics of different species, certain types were used as sled dogs, for herding or protecting livestock, and as guard dogs. Eventually dogs became companions and popular pets.

Canids evolved from a group of small, weasellike mammals known as miacids that appeared in the Paleocene Epoch, about 60 million years ago. The miacids gave rise to the first canids, such as *Cynodictis*, during the Eocene, about 40 million years ago. The genus *Hesperocyon* appeared in North America during the following Oligocene, beginning the main line to modern dogs. *Hesperocyon* was followed by the Miocene *Cynodesmus*, the Pliocene *Tomarctus*, and finally by *Canis* of the Pleistocene and modern times.

In the past the family Canidae was generally grouped with the raccoon, bear, and weasel, either in the superfamily Canoidea or in the infraorder Arctoidea. Many authorities now consider cats and dogs more closely related to each other than to other carnivores, and consequently place them together in a separate superfamily, Cynofeloidea.

dog racing Dog racing, using greyhounds, is a popular wagering sport in 19 states of the United States and in about a dozen other countries worldwide. The racing of carefully bred GREYHOUNDS is derived from the ancient sport of coursing—the pursuit of game with animals that track by sight rather than smell. Egyptians hunted this way as early as 5000 BC. The sport of greyhound racing became popular in Europe during the 16th century; the first formal rules for coursing were established in England in 1776. Those races, as well as the first ones in the United States in 1878, were held on straight courses. Under such rules the fastest, not the smartest, animals won. An American, Owen Patrick Smith of Hot Springs, S.Dak., is credited with establishing oval racing in 1907 at Salt Lake City. Smith was also instrumental in forming (1920) the International Greyhound Racing Association. Florida became the U.S. capital of the sport after dog racing was introduced there in 1922. Today dogs that are fairly evenly matched compete against each other in chasing a mechanical rabbit, called a "lure," attached to an electrical apparatus. U.S. races usually have 8 dogs competing, sometimes 9; races elsewhere run 6 animals, sometimes 8. The greyhounds reach speeds up to 65 km/h (40 mph), and bumping and colliding add to the excitement. State racing associations regulate the sport in the United States because of its association with GAMBLING.

dog show Dog showing, in which dogs compete to earn the title of champion and other honors, is a popular sport in many parts of the world. Dog shows are held under the rules of the various national kennel clubs, such as the American Kennel Club in the United States and the Kennel Club in Great Britain.

To enter a licensed specialty (single-breed) or all-breed show in the United States, a dog must be a purebred at least 6 months of age with no disqualifying faults. To become a champion, a dog must win 15 points (up to 5 in any one show, depending on the number of dogs entered), including two wins in substantial competition under two different judges. Only one dog of each sex in each breed can receive points at a single show; these winners then compete with any champions entered for the Best of Breed award. The Best of Breed winners compete for first in their respective groups, and the seven group winners then vie for the coveted Best in Show award. Judges compare each entry against the standard describing the ideal specimen of its breed, and the Best in Show winner should be the dog most closely resembling its own breed standard.

Field trials, for hunting breeds, and obedience trials are other types of dog-show competitions.

dogbane Dogbane, genus *Apocynum,* or Indian hemp, is an herb of the dogbane family, Apocynaceae. The seven species, all perennials native to North America, have milky sap, fibrous bark and leaves, and small, pale flowers. The shrublike common dogbane, *A. androsaemifolium*, frequently traps small insects in a sticky substance at the base of its loose, flat clusters of pink, bell-shaped flowers.

doge [dohj] The doge, a title derived from the Latin *dux* ("leader"), was the chief magistrate of the Republic of Venice from the 8th century until its fall in 1797. At first the doge was a nearly absolute ruler; in the 12th century, however, his power was curbed by the aristocracy. Some famous doges were the blind Enrico Dandolo (r. 1192–1205), instrumental in diverting the Fourth CRUSADE to capture Constantinople, and Marino Faliero, beheaded

(1355) for trying to make his office despotic. Genoa was also ruled by a doge from the 14th to the 18th century, although the Genoese office had only a 2-year term.

Doge's Palace see VENICE

dogfish The name *dogfish* is applied to at least three families of SHARKS. The spiny dogfish (family Squalidae) is characterized by the absence of an anal fin. The spotted (family Scyliorhinidae) and smooth (family Carcharhinidae) dogfishes have an anal fin. The spiny dogfish, which is the best known, schools in vast numbers on the east coast of North America and is a major pest. Its wild thrashing often results in handlers being stabbed by the spines that precede the dorsal fins. A groove on the back of each spine contains a gland that secretes a painful, although probably never fatal, venom.

Schools of dogfishes apparently travel thousands of kilometers, and the young are born alive. The dogfishes include the smallest known shark, a species that matures at 25 to 30 cm (10 to 12 in) and is restricted to deep waters.

Dogger Bank [daw'-gur] Dogger Bank is a shoal about 260 km (162 mi) long and 100 km (62 mi) wide in the middle latitudes of the North Sea, between Great Britain and Denmark. Its shallow waters, in some places only 15 m (50 ft) deep, are noted for their turbulence and for the great numbers of fish there.

Dogon [doh'-gahn] The Dogon are a West African people of Mali, where they constitute about 4 percent of the total population. They speak a Niger-Congo language and live by subsistence farming, mainly of grain crops. Their political structure is based on deification of the Earth. Accordingly, their villages are under the leadership of ritual headmen whose duty it is to maintain good relations between the people and the Earth. Descent is patrilineal, and marriage residence is with the father's family. Polygynous marriage is permitted but does not predominate. Members of an outcast group work as blacksmiths and wood and leather craftsmen. The Dogon once owned slaves.

The Dogon possess a rich mythology with a symbolic interpretation of the universe in which all persons are described as both male and female in body and in psyche. Their highly developed art forms include representational wood masks and figures. Ancestor worship is important in traditional Dogon religion.

dogsled A dogsled is a sledge, or SLED, drawn by a team of dogs, usually over ice and snow. Probably originating in Siberia and brought (AD *c.*1000) to Arctic North America by Thule people (modern ESKIMO), the dogsled is used primarily by Arctic peoples for long-distance transportation.

A traditional sled consisted of two hollow wooden runners attached to crosspieces by sealskin thongs. A central trace was tied to the front of the sled, and individual lines extended from the central trace. A sealskin harness was tied around each dog's shoulder. The breed commonly used was the husky. The driver sat sideways at the front and turned the sled by pushing or pulling in the desired direction.

dogwood Dogwood is a genus, *Cornus*, of mostly small trees and shrubs in the dogwood family, Cornaceae. About 45 species of *Cornus* are known, almost all of them native to north temperate regions, with 16 endemic U.S. species. Several dogwoods are characterized by the presence of showy, petallike bracts (modified leaves) surrounding each cluster of tiny, inconspicuous flowers. Dogwoods are valued for their flowers or bracts, colored

(Far left) *The flowering dogwood is a beautiful small tree with opposite leaves in spreading branches.* (Left) *The alternate-leaf dogwood bears clusters of flowers and berrylike fruit.*

fruits, and rich autumn color and are often used as single-specimen trees in landscaping. They vary from the bunchberry, or dwarf dogwood, *C. canadensis*—a herbaceous plant, with woody rootstock, that seldom exceeds 23 cm (9 in) in height—to the majestic 23-m (75-ft) Pacific dogwood, *C. nuttallii.*

Flowering dogwood, *C. florida,* is a beautiful eastern U.S. tree. Each cluster of its small greenish yellow flowers is surrounded by four white bracts, notched at the tip and often mistaken for flower petals. In autumn the leaves turn scarlet, and the tree bears clusters of brilliant red, berrylike drupes. The cornelian cherry, *C. mas,* has long been cultivated in Europe and western Asia for its small, plumlike fruits.

Doha [doh'-hah] Doha (1986 est. pop., 217,294), the capital of Qatar, is situated on the east coast of the Qatar Peninsula on the Persian Gulf. Since the discovery of oil in 1939, Doha has changed from a fishing village to a major port city. Once a pirate refuge, the city was under British control from 1916 until 1971.

Dohnányi, Christoph von [doch'-nahn'-yee] The conductor Christoph von Dohnányi, b. Berlin, Sept. 8, 1929, who began full-time directorship of the Cleveland Orchestra in 1984, enjoys a wide reputation as a conductor of opera and of such 20th-century European composers as Schoenberg, Janáček, and Berg. A grandson of composer Ernst von Dohnányi, he is a graduate (1951) of the Munich Musikhochschule and studied under Leonard Bernstein.

Dohnányi, Ernst von The Hungarian musician Ernst von Dohnányi, b. Ernő Dohnányi, July 27, 1877, d. Feb. 9, 1960, toured extensively in his earlier years, achieving international fame as a pianist. Throughout the 1920s and '30s, however, he worked primarily in Hungary as director of the Budapest Academy and conductor of the Philharmonic Orchestra. Exiled from Hungary in 1948, he emigrated to the United States. Of his compositions—which are conservative and romantic in style—the best known is his *Variations on a Nursery Song* for piano and orchestra (1914).

Doisy, Edward [doi'-zee] Edward Adelbert Doisy, b. Hume, Ill., Nov. 13, 1893, d. Oct. 23, 1986, a biochemist, made important discoveries about the chemical nature of sex hormones and about vitamin K, an important factor in blood clotting. The latter work won him a share of the 1943 Nobel Prize for physiology or medicine; Carl Dam, the corecipient, discovered the vitamin. Doisy and Edgar Allen searched for the chemical responsible for the physiological effects of ovarian preparations and isolated (1929) the female sex hormone estrone. They later isolated the hormones estriol and es-tradiol.

doldrums [dohl'-drumz] The doldrums are an equatorial ocean region of light, variable winds and slow ocean currents (see wind). Within this belt, called the intertropical convergence zone, the northeast and southeast trade winds meet, producing a slow uplift of air and few strong pressure gradients. Calms are prevalent about one-third of the time. Heavy rains occur as condensation forms in the ascending and continually replenished warm, moist air. Much precipitation and reduced evaporation make surface waters in these regions less saline than elsewhere.

Dole, Robert J. The U.S. Republican senator Robert Joseph Dole, b. Russell, Kans., July 22, 1923, was Senate majority leader (1985–87). After serving in the Kansas legislature (1951–53) and practicing law, Dole was elected to the U.S. House of Representatives (1960) and then to the U.S. Senate (1968). He was Gerald Ford's vice-presidential running mate in 1976, and in 1980 and 1988, Dole unsuccessfully sought his party's presidential nomination. Senator Dole is married to Elizabeth Hanford Dole, U.S. secretary of transportation (1983–87) under Ronald Reagan and secretary of labor (1989–90) under George Bush.

Dole, Sanford Ballard Sanford Ballard Dole, b. Honolulu, Apr. 23, 1844, d. June 9, 1926, was a political leader of Hawaii. The son of American missionaries, Dole helped launch the 1887 revolution that produced a democratic constitution for Hawaii. After the ouster (1893) of Queen Liliuokalani he was elected (1894) president of the Republic of Hawaii. Dole worked to secure American annexation (1898) of Hawaii, headed the commission that drafted the Organic Act of 1900, and served (1900–03) as the first governor of the U.S. Territory of Hawaii.

doll Dolls, small representations of people, have been used since the beginning of human culture, either as symbols in religious worship, as burial objects, or as children's playthings. Doll-like artifacts have been found in ancient burial sites around the world, made of materials that range from clay, wood, and leather to bone and ivory. Archaeologists surmise that many ancient doll figures may have been used as either religious or play objects. Among the Hopi and Zuñi Pueblo Indians, the kachina pantheon of god-dolls had its counterpart in the Tikus, the wooden dolls that served as educational toys for the children of the tribes.

Many of the dolls that the Greeks and Romans made for their children were jointed, and the Greeks also devised puppet dolls with movable arms and legs. Although little is known about the use of dolls in early Christian Europe, crèche figures, extraordinarily lifelike dolls used in Nativity scenes, appeared in Europe during the 14th

From the 16th century onward, German dollmakers were famous for their craftsmanship. Nineteenth-century German dolls such as these had delicate porcelain faces and eyes that opened and closed. (Stadtmuseum, Munich.)

century and inspired the manufacture of secular dolls, doll houses, and miniature furnishings. The fashion doll, used to model clothing styles, also came into popularity during the 14th century and continued in use until the late 1800s.

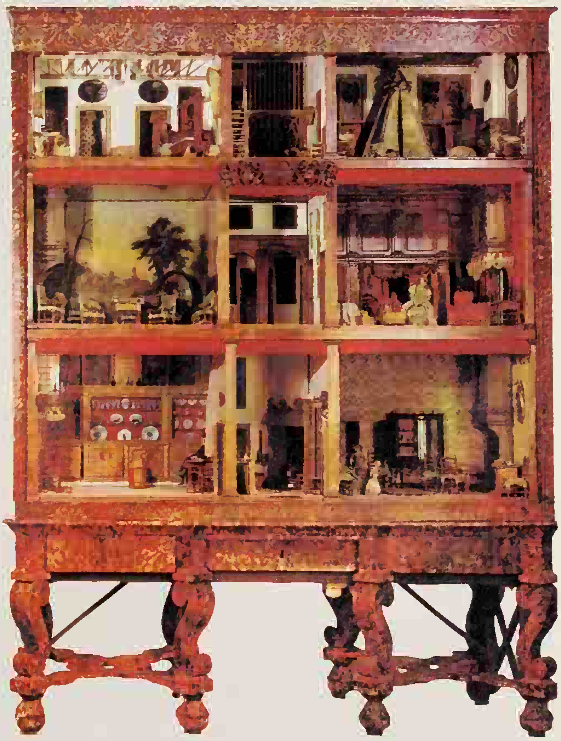
Industrial production of dolls, however, did not begin until the 19th century, when techniques for making dolls' heads and limbs from porcelain, and, later, from an unglazed china called bisque, were developed in France and Germany. Doll bodies were made of cloth or leather, and the china parts attached. In recent years, interest in collecting 19th-century dolls has spawned an industry devoted to manufacturing porcelain dolls in molds taken from the originals.

Other materials used to make dolls have included rags, papier-mâché, rubber, leather, gutta-percha, celluloid, and bakery dough. Where they grow, palm leaves, the shucks of corn, and bamboo make distinctive types of dolls. Plastic is the most common material for contemporary dolls. New vinyls can be molded to create uncannily lifelike dolls, some of which can also drink, cry, wet, walk, or speak. Beginning in the 1960s adult-featured dolls, such as the long-legged "Barbie," became highly popular. In the mid-1980s the "Cabbage Patch Kids" dolls attracted wide attention for a while because each doll had a different face and clothing and came with its own name and "birth certificate."

doll house Houses in miniature, often filled with miniature furniture and furnishings, doll houses have been among the most elaborate of children's playthings. Although historical records of doll houses cannot be found before the 16th century, it is believed that—in Europe at least—the doll house may have been inspired by the medieval church crèche. Many doll houses were built for the wealthy, either as toys for their children or as a means of displaying collections of miniature objects and valuable curios. Called art "cabinets," these were often elaborate scale models of the owners' houses or were designed as representations of idealized stately buildings.

From the 18th through the early 20th century, England produced a number of splendid doll houses. Among the most famous is *Queen Mary's Dolls' House*, designed by architect Sir Edwin Lutyens, and built over four years by a panoply of British craftsmen. Finished in 1924, the house contains, among innumerable treasures, a garden that folds away into a drawer when the house is shut up for the night and a library of 200 miniature books, handwritten by celebrated authors of the time. The Museum of the City of New York displays a famous U.S. doll house from the same period, which boasts an art gallery with

The doll house probably evolved from the medieval crèche, an ornate nativity scene common in Catholic Europe; elaborate doll houses were made in Protestant countries, where religious figures were banned. This detailed house was crafted in 1762. (Rijksmuseum, Amsterdam.)



miniatures painted by such artists as Marcel Duchamp and Gaston Lachaise.

dollar The dollar is the main currency unit of the United States, Canada, Australia, New Zealand, Liberia, and several former British colonies. As part of a decimal currency system, it consists of 100 cents.

The U.S. dollar, adopted in 1792, was based on a Spanish coin that had circulated in the colonies before the American Revolution. The first U.S. dollars were issued in silver and gold. Gold $10, $5, and $2.50 coins were issued from 1795 to 1933. From the middle of the 19th century, gold coins valued at $1, $3, $5, $10, and $20 were also minted; after 1934, however, all gold coins were taken out of circulation. A silver dollar was issued at various times from 1794 until 1935. Minting of the silver dollar was resumed in 1971, with the issuing of the Dwight Eisenhower dollar. (This dollar for circulation contains no silver; specially minted—and higher priced—numismatic dollars contain 40% silver.) In 1979 a smaller dollar coin, bearing the head of Susan B. Anthony, was issued; the public found it confusingly similar in size with the 25¢ coin, and the small dollar quickly fell into disuse. Paper dollars were first issued in America in 1775 and have appeared in amounts of $1, $2, $5, $10, $20, $50, $100, $500, $1,000, and $10,000. In 1969 issuance of currency in denominations larger than $100 was discontinued.

Canada adopted the dollar and monetary decimal system in 1878, Australia in 1966, and New Zealand in 1967.

After World War II the U.S. dollar became the principal reserve currency in international exchange. The CENTRAL BANKS in most trading countries began to use dollars as a reserve asset in the same way that they had traditionally used gold. The international monetary system, as institutionalized in the INTERNATIONAL MONETARY FUND, was based on the strength of the dollar and on the readiness of U.S. authorities to exchange dollars for gold at a rate of $35 to one ounce. By the 1970s, however, conditions had changed. The United States was no longer the only strong economic power, and the dollar was beginning to suffer some of the same ills that had afflicted other currencies in the past. In August 1971 the United States stopped exchanging dollars for gold, and soon afterward other countries stopped exchanging their currencies for dollars at fixed rates. The value of the dollar against other currencies came to depend on several factors: the size of the deficit in the U.S. BALANCE OF PAYMENTS, the financial policies of other countries, and the confidence of foreigners in U.S. economic management.

Dollfuss, Engelbert [dohl'-fus, eng'-el-bairt] Engelbert Dollfuss, b. Oct. 4, 1892, was chancellor of Austria from May 1932 to July 25, 1934, when he was assassinated in an abortive Nazi coup. A Catholic conservative, he aimed to maintain Austrian independence from Nazi Germany with help from Fascist Italy. In March 1933 he suspended parliamentary government, and after crushing a deliberately provoked Socialist uprising (February 1934), Dollfuss established a dictatorship in April 1934. He was murdered by Austrian Nazis before the new regime was fully operative.

Döllinger, Ignaz von [dur'-ling-ur, ig'nahts fuhn] Johann Joseph Ignaz von Döllinger, b. Feb. 28, 1799, d. Jan. 10, 1890, was a German church historian and one of the principal opponents of the Roman Catholic dogma of papal INFALLIBILITY. Ordained a priest in 1822, he became professor of church history at the University of Munich.

Döllinger criticized the proposed dogma in articles published as *The Pope and the Council* (1869). When the First VATICAN COUNCIL defined (1870) the doctrine as meaning that the teachings of a pope on faith and morals are infallible under certain conditions, Döllinger, who had not been invited to the council, refused to accept it and was excommunicated as a result.

Doll's House, A *A Doll's House* (1879), a realistic play by Henrik IBSEN, deals chiefly with marriage. The English title is a misleading translation of the Norwegian *Et Dukkehjem*; it should be *A Doll House*. Nora and Torvald Helmer are the two leading characters; the unfolding of their nonrelationship—two wedded strangers who have spent eight years in a "dollhouse"—is the primary action. The emerging relationship of Krogstad and Kristine Linde, in contrast to that of the Helmers, suggests another theory of marriage: reciprocal give-and-take between equals. Despite such devices as coincidences and discovered letters, the play, one of Ibsen's most frequently performed, retains literary and theatrical value because of its psychological characterizations.

dolmen see MEGALITH

Dolní Věstonice [dawl'-nyee vyes'-tohn-yeet-seh] Dolní Věstonice, located 25 km (15 mi) south of Brno, Czechoslovakia, is perhaps the most important of the Eastern Gravettian mammoth-hunter sites. Excavated between 1923 and 1987, the settlement has yielded thick layers of animal bones—notably those of more than 100 young mammoths— discarded near huts made of tusks, bones, branches, and probably skins. Charcoal from the hearths has been dated to about 26,000 years ago. Thousands of lumps of fired clay, many representing animal forms, and the remains of two kilns constitute the earliest evidence for ceramic manufacturing. Other examples of PREHISTORIC ART found there include an ivory human head and a small female "Venus" figurine.

dolomite [doh'-luh-myt] Dolomite, $CaMg(CO_3)_2$, is, after CALCITE, the second most important and abundant of the CARBONATE MINERALS. Half the calcium ions of calcite are replaced by magnesium, and iron may substitute for magnesium to form an isostructural series with ankerite, $Ca(Fe, Mg)(CO_3)_2$.

The physical properties and CRYSTAL structure resemble those of calcite, and dolomite occurs in similar geologic settings: in IGNEOUS ROCKS as carbonatite, in metamorphic rocks as MARBLE, and in hydrothermal deposits. The most abundant occurrences are in SEDIMENTARY ROCKS. Rocks composed of dolomite form vast deposits, as in the Alpine range known as the DOLOMITES. Dolomite is quarried for building and ornamental stone and is a major source of magnesium.

Dolomites [doh'-luh-myts] The Dolomites are a mountain group of the eastern ALPS located in northern Italy. The mountains are almost completely surrounded by the river valleys of the Adige, Piave, Brent, Isarco, and Rienza. Covering an area of about 4,100 km^2 (1,600 mi^2), 18 of the range's tallest peaks rise to more than 3,050 m (10,000 ft). The highest point is Marmolada (3,342 m/10,964 ft). The mountains are composed of dolomite that has been eroded into jagged pinnacles and deep gorges. Glaciers remain on the upper slopes.

dolphin The majority of small-toothed WHALES are called dolphins. They are mammals of the order Cetacea and the families Platanistidae, Delphinidae, and Grampidae and include about 50 species. All have a beaklike snout and sharp, conical teeth. The term *porpoise* is sometimes applied to many of the same species, but porpoises, strictly speaking, are members of the family Phocaenidae and have a blunt snout and spade- or chisel-shaped teeth (see PORPOISE). The dolphin fish (mahi-mahi, or dorado) is a sport fish related to the mackerels.

Most dolphin species are about 2 m (6 ft) in length, the males averaging 10 to 20 cm (4 to 8 in) longer than females. The largest is the bottle-nose dolphin, *Tursiops truncatus*, well known in many public aquariums. This species may reach over 3 m (9 ft) in length and 200 kg (440 lb) in weight. The smallest species is the buffeo, *Sotalia fluviatilis*, found in the Amazon River; the buffeo rarely grows over 1.2 m (3.9 ft) in length and 30 kg (66 lb) in weight.

Dolphins are predators and feed on live food, except when trained otherwise in captivity. The primary food is fish, mostly open-water types such as herring, mackerel, and sardines. Some species seem to prefer squid; occasionally shrimp and other crustacea are consumed, and even mollusk shells have been found in their stomach contents. Food consumption is estimated at about 30 kg (66 lb) a day for an individual about 2.5 m (8.2 ft) in length and 100 kg (220 lb) in weight.

Range. Dolphins can be found in virtually all the seas

(Left) *The bottle-nosed dolphin is playful, intelligent, sociable with humans, and easily trained.* (Below, left) *The pilot whale often travels in herds of several hundred. These whales have an innate urge to follow runaway members of the herd blindly. Often an injured whale will lose its echolocation ability and swim into shallow water. The rest of the herd follow, becoming stranded.* (Below) *Most dolphins inhabit the open seas, but the bouto, or Amazon, dolphin lives in the Amazon and Orinoco river systems of South America.*

and oceans of the world. Some species are sharply restricted, but many, such as the common dolphin, *Delphinus delphis*, or the bottle-nose dolphin, are found worldwide. Several species are found in freshwater, notably the Ganges River dolphin, *Platanista gangetica*; the rivers of South America are the home of the long-snouted dolphin, *Inia geoffrensis*, and the buffeo.

Dolphins are quite abundant in some areas of the world. Off the coast of Japan, for example, populations of the white-sided dolphin, *Lagenorhynchus obliquidens*, are estimated at 30,000 to 50,000 individuals. In many species, schools of up to 1,000 travel together. Others, such as the bottle-nose dolphin, tend to be found in groups of less than 100, or even just a small family group. Solitary dolphins are rare.

Physiology. The general form of dolphins is a classic example of streamlining. The body is sleek and smooth; the hairless skin is rubbery to the touch. Above the upper jaw is a large mass of fat and oil-containing tissue forming the so-called "melon" that looks much like a bulging forehead.

The anterior appendages contain the skeletal remnants of five digits that form the flippers, which the animal uses primarily as stabilizers. The hind appendages are virtually absent and consist of a pair of small pelvic bones. The dorsal fin is formed from subcutaneous dermal tissue and is not movable by muscle action. The caudal, or tail, fin is also primarily dermal in origin and consists of a pair of horizontally extending flukes. Locomotion is typical of the whale. The main thrust comes from vertical oscillations of the tail and flukes. Most species tested are capable of sustained swimming speeds of up to 30 km/h (18.6 mph).

Because dolphins are mammals, they must breathe air and maintain a high body temperature. The maintenance of internal temperature is aided by a thick layer of dense fat (blubber) under the skin. Air is breathed through a specialized single nostril, or blowhole, situated almost directly on top of the head. The dolphin normally comes to the surface to breathe about every two minutes, and each breath consists of a short, almost explosive exhalation, followed by a slightly longer inhalation. Dolphins are capable of rapid and deep dives of more than 300 m (1,000 ft). The respiratory system is specially modified to avoid the BENDS.

Reproduction. Reproductive behavior is known mostly from studies on captive individuals, primarily the bottle-nose dolphin. Copulation normally occurs during the spring months, with the male-female pair exhibiting courtship for some time prior to copulation. Gestation in the species studied is between 11 and 12 months, after which a single calf is produced. Delivery is normally tail first, and the newborn is capable of swimming and breathing within the first minutes. Some mothers have been observed raising the calf to the surface, as if to help it, but dolphins apparently play in this fashion with a variety of objects, living or not. Such play may have provoked the stories of drowning persons being helped to shore by dolphins.

After birth, the calf follows its mother closely, and suckling takes place frequently. The dolphin's two mammary glands open into sacs on either side of the anal opening, and the calf's beak fits into the sacs. The nipple is grasped between the upper jaw and the tongue; muscular contractions by the mother literally squirt milk into the calf's mouth.

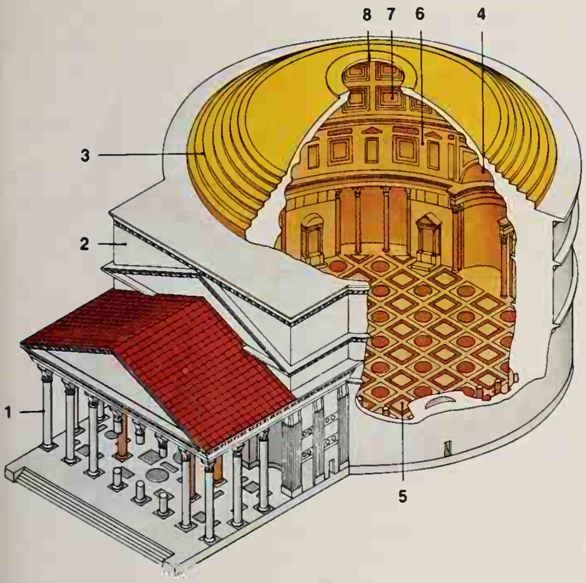
Communication. Dolphins are extremely and almost constantly vocal. They are capable of two kinds of sounds. Short, pulse-type sounds are emitted by a specialized mechanism in the nasal passages just below the blowhole. Each sound comprises a broad range of frequencies, including many in the ultrasonic range. The sounds, called clicks, can be produced in such rapid succession as to resemble a buzz or even a ducklike quack. The clicks are beamed forward, with the oily melon serving as an acoustic lens and the bony forehead as a reflector. The clicks are used as a form of sonar, in which echoes of sounds from surrounding objects enable the animals to detect obstacles, other dolphins, fish, and even tiny bits of matter in the water. This ability, termed ECHOLOCATION, is found in a few other animal groups. Some scientists have speculated that dolphins also use the sounds to deliver an acoustic shock for stunning or killing small prey.

Deeper in the respiratory system—presumably in the larynx—dolphins produce another type of sound: a high-pitched whistle or squeal, which is capable of rapid pitch changes. The whistles, essentially single tones, apparently are used to communicate a particular emotional state and thus influence the behavior of other dolphins. Typically the squeals denote alarm or sexual excitement.

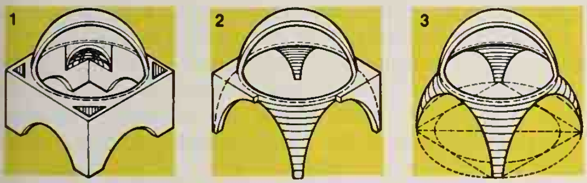
Intelligence. Because dolphins are highly social and vocalize among themselves, it has been conjectured that they might possess an almost humanlike intelligence. In the 1950s and 1960s the American neurologist John Lilly conducted experiments based on this concept; other scientists have rejected Lilly's work as poorly documented and lacking scientific validity. Most researchers agree that dolphins exhibit a level of intelligence greater than that of dogs and even comparable to that of some primates—but not human beings.

dome The dome is one of the most significant structural types in the history of architecture. It may be thought of as a large vault produced by spinning an arch on its vertical axis. A true dome is hemispherical, but domes may also be pointed or bulbous. Some recent innovations called domes, such as the GEODESIC DOME, are architecturally dissimilar structures.

A dome is usually erected over a wooden framework called the centering, which is removed once the mortar has set. As with all types of arched vaults (see ARCH AND VAULT) constructed of stone or brick, the dome exerts a downward and outward pressure, or thrust, resulting from the pull of gravity on its parts. This thrust is counteracted by means of abutment or structural support. If the chamber covered by a dome is square or polygonal, two devices may be employed at the angles to effect the transition



The Pantheon, built about AD *118–28, is surmounted by a hemispheric dome. The portico features granite columns* (1) *topped by marble Corinthian capitals. An intermediate block* (2) *leads to the rotunda, which is roofed by a stepped dome* (3). *Of the seven exedrae, the main one* (4) *has a semidome. The floor* (5) *was restored during the 19th century. The upper portion of the rotunda wall, the attic* (6), *is faced with pilasters and paneling; above it rise five ranges of coffering* (7). *The central oculus* (8) *is the only source of light.*



The Byzantines devised a method for the architectural transition of polygonal foundation to dome by inventing concave triangles called pendentives to provide a graceful basis for the sphere. The squinch arch (1) *was refined and heightened* (2) *to allow the bottom points, which absorb the dome's weight, to rest on a square base* (3).

to the circular dome or, in many cases, to a cylindrical drum on which the dome may rest. These devices are the pendentive, a shelf of masonry shaped like a curved or sectional triangle, and the squinch, a series of superimposed arches, each arch projecting slightly forward over the one beneath it.

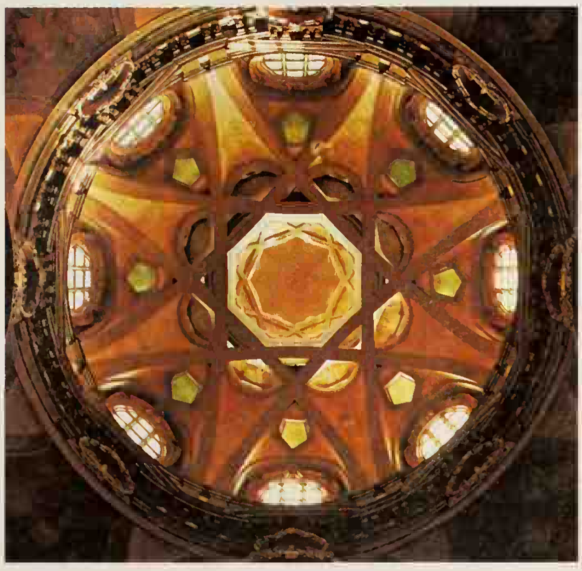
The earliest known domical coverings date back to the 2d millennium BC in Egypt and Mesopotamia. The Romans, having developed the use of poured concrete (see Roman art and architecture), were the first to exploit the dome fully as an architectural feature. The umbrella, or melon, dome was a series of semicircular concave sections, as at the vestibule of the Piazza d'Oro of Hadrian's Villa at Tivoli (AD 118–25). The largest and most famous of all Roman masonry domes is that of the Pantheon (AD 118–28), with a single opening, or oculus, at the top and a coffered inner surface that reduces its weight.

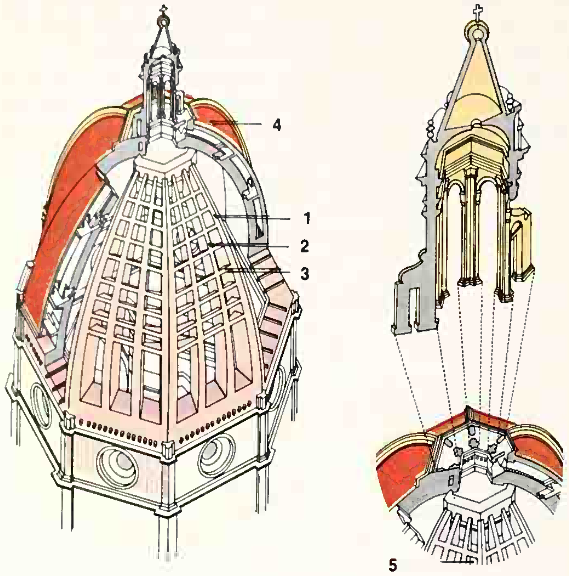
With the advent of Early Christian architecture (see Early Christian art and architecture) in the 4th century, the dome was no longer used for major structures in the West but was employed only for small-scale centralized baptisteries, mausoleums, and martyria. The major ecclesiastical building was the horizontally oriented Christian basilica. In the East, on the other hand, from the 6th century on, Byzantine architects (see Byzantine art and architecture) adopted the central plan for large-scale churches, achieving a remarkable flow of space through a succession of domes and half-domes dependent on each other for receiving the thrusts, as in the Church of Saints Sergius and Bacchus in Constantinople (now Istanbul), begun 525. To contemporaries, the vault of Hagia Sophia in Constantinople (532–37) appeared to be suspended from heaven.

The revitalization of the dome in the East made widespread the use of domical coverings in Byzantine possessions in the West, as at San Vitale (526–28) in Ravenna, in medieval Europe, and particularly in Russia. The impact was also felt in Islamic architecture (see Islamic art and architecture), where pointed domes and supporting ribs were common. Perhaps the best known of all domed Islamic structures is the Taj Mahal (1631–48; Agra, India).

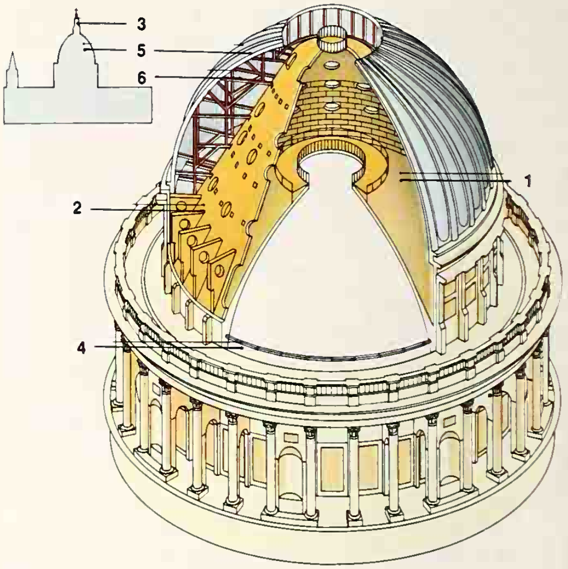
Church design during the Italian Renaissance (see Renaissance art and architecture) was greatly influenced by Neoplatonic doctrine, which interpreted the circle and

The conical dome (seen from below) of Giovanni Guarini's baroque Church of San Lorenzo (1668–87) in Turin, Italy, is composed of curvilinear ribs and arches. Eight ribs, interrupted by windows, support the turret, or lantern.





The construction of the dome of Florence Cathedral, designed and built (1420–36) by the Italian architect Filippo Brunelleschi, reflects the vaulting methods used in the Pantheon. The dome is pointed, not hemispheric. Vertical ribs support the structure, with 8 major ribs (1) *rising from the octagon's angles and 16 minor ribs* (2) *within the major ribs. The dome is strengthened by horizontal ties* (3). *Its interior is protected by a thin double shell* (4). *A passage leads between the two layers to the base of the lantern* (5).



Sir Christopher Wren's ingenious design for the dome of St. Paul's Cathedral (1675–1710) required a triple-dome construction. The shallow inner dome (1) *of brick rises 65.3 m (214.5 ft) above the cathedral floor. A conical intermediate dome* (2), *also of brick, supports the turret, or lantern* (3). *Double iron chains* (4) *provide additional reinforcement for the intermediate dome. The outer dome* (5), *a light cupola of lead-covered timber, rests on a wooden framework* (6) *attached to the intermediate dome.*

other simple geometric shapes as emblems of wisdom. The standard Renaissance scheme may be seen in the drawings of Leonardo da Vinci and Donato Bramante (Parchment Plan of Saint Peter's, 1506; Uffizi, Florence): a ring of satellite domes and vaults buttresses the dominating central dome, toward which the soul of the inspired observer was supposed to rise in contemplation. Whereas Roman and Byzantine domes had been designed to be viewed from the interior and had relatively little external impact, the Renaissance dome, elevated on a drum, was a striking and clearly distinguishable form against the urban skyline. In the United States the domes of numerous capitol buildings and town halls were modeled after European prototypes, the largest being that of the Capitol of the United States in Washington, D.C. (1855–65).

Dome of the Rock see MOSQUE

Domenichino [doh-may-nee-kee'-noh] Domenichino, the abbreviated name of Domenico Zampieri, b. Oct. 21, 1581, d. Apr. 6, 1641, was a major Italian painter of the baroque period. Domenichino's many important commissions in Rome included frescoes (1613–14) of the life of Saint Cecilia for the church of San Luigi dei Francesi, the *Assumption of the Virgin* on the ceiling of the church of Santa Maria in Trastevere (1617), and frescoes in the church of Sant'Andrea della Valle (1624–28). His best-known paintings are the *Last Communion of Saint Jerome*, painted for the church of San Girolamo della Carità (1614; now in the Vatican Museum), and the *Lady with a Unicorn* (*c.*1602; Palazzo Farnese, Rome).

In Naples after 1631, Domenichino painted frescoes and six altarpieces in the chapel of San Gennaro in the Cathedral. His success—as well as his difficult personality, which had made him unpopular with other artists in Rome—aroused animosity among painters in Naples. It is rumored that his death was caused by poisoning.

Domenichino's restrained style was rooted in classicism. His most important contributions are his lyrical landscapes, which were much admired by the painters John Constable, Claude Lorrain, and Nicholas Poussin.

Domenico Veneziano [doh-may'-nee-koh, vay-nay-tsee-ah'-noh] Domenico Veneziano, *c.*1400–*c.*1461, was an accomplished northern Italian painter, most of whose work has not survived. Although his name implies Venetian origins, his painting has nothing in common with the style of the Venetian school, and he spent much of his working life in Florence, where he executed a group of frescoes (now lost) with the assistance of Piero della Francesca.

The graceful style of Domenico's work is exemplified by his two Madonnas in the Berenson Collection, Florence, and the National Gallery, Washington, D.C. His major work, the *St. Lucy Altarpiece* (*c.*1445; Uffizi, Florence), is one of the earliest works to bring the Madonna and saints together in a group. It displays both his familiarity with earlier Florentine masters and his chief contribution to Italian painting: the use of brilliant color and the solid but delicate handling of the human form.

Domesday Book [doomz'-day] A census of the English kingdom commissioned by WILLIAM I (William the Conqueror) in 1085, the Domesday Book was completed in 1086. Without equal as a public record in medieval Europe, the survey details the taxable potential of lands held by the king and of those allotted to his tenants-in-chief. Despite some errors and omissions, the Domesday Book is a fairly complete record of conditions among the ruling class in late Anglo-Saxon and early Norman times. Legitimizing the social changes imposed upon England by the Norman conquerors, the document provided the monarchy with a detailed account of the feudal financial resources that it could exploit in the future.

The census was prepared by commissioners who traveled throughout the kingdom collecting information on the status of the land, and marking the changes that had occurred since the beginning of William's reign. Their reports were compiled in two volumes: one, the Great Domesday, summed up data from all the counties surveyed except for Norfolk, Suffolk, and Essex. A more detailed description of those areas is contained in the second volume, called Little Domesday. The northernmost parts of England (Northumberland, Cumbria, and Durham) were not surveyed. The Domesday Book is preserved in the Public Record Office in London.

The name *Domesday*, a reference to the Last Judgment, was given to the census because it was a record from which there was no appeal.

domestic architecture see HOUSE (in Western architecture)

domestic service Domestic service today comprises such paid household occupations as cleaning, cooking, and laundering. However, until the 19th century, domestic servants usually included all nonfamily persons who worked within a private house or estate, with the exception of agricultural workers; and, until well into the Renaissance, in many parts of Europe such servants were either slaves, serfs, or family dependents. It is thought that half the slave population in Athens was in domestic service (see SLAVERY).

The Greek pattern of domestic employment was repeated in its essentials throughout all the early Mediterranean societies, in Rome, and in western Europe until the decline of serfdom in the late Middle Ages. However, other forms of dependency continued. Under the medieval guild system, apprentices were required to act as servants to the master who was teaching them their trade. In the early American colonies domestic servants were often indentured, or bond, servants who had sold their services for a specified period of time in return for their passage to the New World. Eventually, servants became wage earners; but even as late as the 19th century, European domestics were considered a dependent class, without the status accorded other citizens. The number of people in paid domestic service reached its peak in 19th-century Europe. This growth of the servant class was, in part, a result of the increase in the number of urban, middle-class households that could afford to keep servants. The proportion of women employed as servants also grew, so that by 1891, almost 1.4 million female domestics (including 107,000 girls between 10 and 15 years of age) worked in private homes in England and Wales, and only about 60,000 males. Women were paid, on the average, one-third to one-half less than men. Nevertheless, servants' wages (supplemented by food and shelter supplied by employers) were in general better than those of factory workers, and prospects for advancement were considerably brighter. With diligence, intelligence, and luck, a housemaid might eventually rise to the rank of housekeeper, the most exalted position a woman could hold in the domestic hierarchy of a great English house; a kitchen maid might become a cook; a footman or groom could hope to advance himself to valet or even, perhaps, to butler or steward.

A kitchen maid admires her handiwork in this 1897 advertisement. Domestic service was one of the few sources of employment for thousands of women immigrants, and for many it provided an introduction to a new language and culture.

In the United States in the late 19th century, although female servants effectively earned more than factory or sweatshop workers and held positions that were far more secure, domestic service was widely held to be demeaning. Domestic positions were usually taken by newly arrived immigrants or by black women who were denied other forms of employment. In 1870 one-half of all the working women in the United States were cooks, laundresses, or domestic servants. By 1930 that number had shrunk to 18.5 percent, the majority of them black women. Job opportunities in industry opened for women during the period of World War II, diminishing the number of servants even further. Today, few women hire out as domestics. Those who do—unlike servants of past generations—must be paid at least the minimum wage.

The hiring of illegal immigrants as domestic workers was a fairly common practice until the passage of the Immigration Reform and Control Act of 1986 (see IMMIGRATION), which increased the penalties that could be imposed on the employers of such labor. The need to find household help remains pressing, however, for the growing number of women who work outside the home.

domestication of plants and animals see AGRICULTURE, HISTORY OF; ANIMAL HUSBANDRY; NEOLITHIC PERIOD; PLANT BREEDING

Domingo, Placido The operatic tenor Placido Domingo, b. Madrid, Jan. 21, 1941, grew up in Mexico City and sang his first roles there with the City Opera, later joining the Tel Aviv Opera. He emerged as an international singer after appearances (1966) in Ginastera's *Don Rodrigo* at the New York City Opera. A debut (1968) at the Metropolitan Opera as Maurizio in *Adriana Lecouvreur* led to a close association with that company. His expressive, mellow voice and attractive stage appearance have brought him great popularity. Domingo has also conducted opera.

Dominic, Saint Saint Dominic, b. *c.*1171, d. Aug. 6, 1221, was the founder of the DOMINICANS. He was ordained a priest at about the age of 28 and was named assistant prior of the chapter of canons at the cathedral of Osma. Dominic accompanied his bishop to Denmark on a diplomatic mission in 1203 and again in 1205. Traveling through southern France, they saw the problems caused by the ALBIGENSES and the military and religious efforts made to suppress them. With his bishop, Dominic began (*c.*1206) to preach to both the Albigenses and another dissident group, the WALDENSES. He adopted the life-style of simplicity and poverty that these groups practiced.

Dominic organized (1206) women converts from the Albigensian movement into a religious community, the beginning of the Dominican nuns. In 1215 he gathered around him a community of preachers, who would be both poor and learned in theology, the beginning of the Dominican male religious order. In an inaccurate tradition, Dominic is also credited with instituting the popular devotion of the ROSARY. In art, he is often pictured receiving a rosary from the Virgin Mary. Feast day: Aug. 8 (formerly Aug. 4).

Dominica [dah-muh-nee'-kuh] Dominica, one of the smallest countries in the Western Hemisphere, is located in the Lesser ANTILLES of the Caribbean Sea; Roseau, the

AT A GLANCE

COMMONWEALTH OF DOMINICA

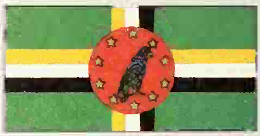
Land: Area: 751 km^2 (290 mi^2). Capital and largest city: Roseau (1987 est. pop., 22,000).

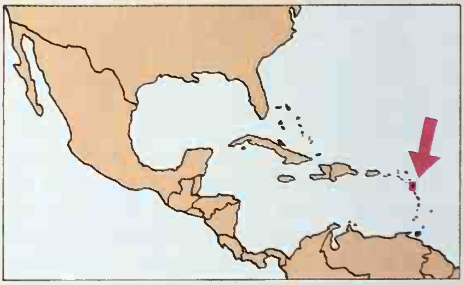
People: Population (1990 est.): 84,854. Density: 113 persons per km^2 (293 per mi^2). Distribution, urban/rural: not available. Official language: English. Major religion: Roman Catholicism.

Government: Type: republic within Commonwealth. Legislature: House of Assembly. Political subdivisions: 10 parishes.

Economy: GDP (1987): $137 million; $1,408 per capita. Labor distribution (1987): agriculture—40%; industry and commerce—32%; services—28%. Foreign trade (1988): imports—$66 million; exports—$46 million. Currency: 1 East Caribbean dollar = 100 cents.

Education and Health: Literacy (1986): 94.4% of adult population. Universities (1987): 1. Hospital beds (1985): 292. Physicians (1985): 25. Life expectancy (1990): women—79; men—73. Infant mortality (1990): 13 per 1,000 live births.





capital, is the island's main port.

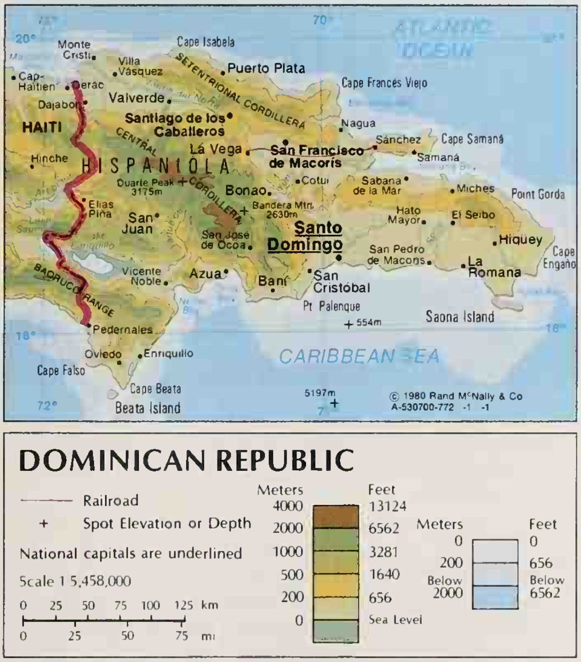
A mountainous island of volcanic origin, Dominica is covered with forests. None of its many rivers is navigable. The annual average temperature is about 26° C (79° F), and rainfall may reach 6,350 mm (250 in) in the mountains, the highest of which is Morne Diablotin (1,447 m/4,747 ft).

The population is predominantly black, with a small settlement of CARIB Indians (descendants of the first inhabitants) in the interior. The official language is English, but many people speak a French patois. The largest segment of the labor force is agricultural, producing bananas and coconuts for export. There is a small tourism industry.

Christopher Columbus discovered Dominica on Nov. 3, 1493. In the 18th century it was contested between Britain and France but was under British control by 1805. It became independent on Nov. 3, 1978, as a member of the Commonwealth of Nations. In 1983, Prime Minister Eugenia Charles (elected in 1980), on behalf of the seven-nation Organization of Caribbean States, formally requested that the United States intervene militarily in neighboring Grenada. In 1990 she won a third five-year term. Hurricane Hugo struck the island in 1989, causing widespread damage.

Dominican Republic

Dominican Republic The Dominican Republic occupies the eastern two-thirds of the Caribbean island of HISPANIOLA, located between Cuba and Puerto Rico. Haiti occupies the western third. Columbus landed on the island in 1492, and the earliest Spanish colony in the Americas was established there. Independent since 1844, the Dominican Republic has been dependent upon U.S. economic interests for much of its history.



AT A GLANCE

DOMINICAN REPUBLIC

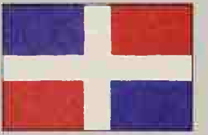
Land: Area: 48,734 km^2 (18,816 mi^2). Capital and largest city: Santo Domingo (1987 est. pop., 1,700,000).

People: Population (1990 est.): 7,240,793. Density: 149 persons per km^2 (385 per mi^2). Distribution (1989): 56% urban, 44% rural. Official language: Spanish. Major religion: Roman Catholicism.

Government: Type: republic. Legislature: National Congress. Political subdivisions: 29 provinces, 1 national district.

Economy: GDP (1988 est.): $5.1 billion; $790 per capita. Labor distribution (1986): agriculture—49%; services—33%; industry—18%. Foreign trade (1988): imports—$1.8 billion; exports—$711 million. Currency: 1 Dominican Republic peso = 100 centavos.

Education and Health: Literacy (1988): 74% of adult population. Universities (1988): 8. Hospital beds (1985, under government auspices): 6,511. Physicians (1985) 3,056. Life expectancy (1990): women—69; men—65. Infant mortality (1990): 62 per 1,000 live births.



A team of Santa Gertrudis cattle, developed for their resistance to heat and disease, plow a field in Santiago province of the Dominican Republic. Agriculture is being diversified in order to depend less on sugarcane.

Land and People

Hispaniola is a mountainous island, with the most important chain, the Cordillera Central, extending across the western section of the Dominican Republic. The highest and the lowest points in the whole Caribbean area lie within a short distance of each other in the Dominican Republic. The highest point is Duarte Peak, with an elevation of 3,174 m (10,414 ft); the lowest point (45 m/148 ft below sea level) is found at Lake Enriquillo, only 85 km (50 mi) to the southwest. In the north, running parallel to the Atlantic, is a fertile agricultural region known as the Cibao Valley, drained by the North Yaque River. SANTO DOMINGO, the capital, largest city, and largest port, is located on the southern coast. The tropical climate (average annual temperature, 25° C/77° F) is ameliorated at the higher altitudes and by the northeastern trade winds. Rainfall averages from 762 mm (30 in) along the Haitian border in the southwest to 2,540 mm (100 in) in the northeast.

The Dominican population is the result of nearly 4 centuries of mixing of European and African elements. The original Indian inhabitants were either absorbed or eliminated within the first 100 years of the Spanish conquest. Haitians are the largest minority group. The population is 95% Roman Catholic. Primary education is free and compulsory for children 7 to 14 years old. The country has 8 universities, including the University of Santo Domingo (1538), the Americas' oldest.

Economy

Agriculture is the traditional mainstay of the Dominican economy, with sugarcane being the leading cash crop produced for export. Other important export crops are cocoa and coffee. Nickel is the leading mineral export; bauxite, gold, and rock salt are other significant mineral resources.

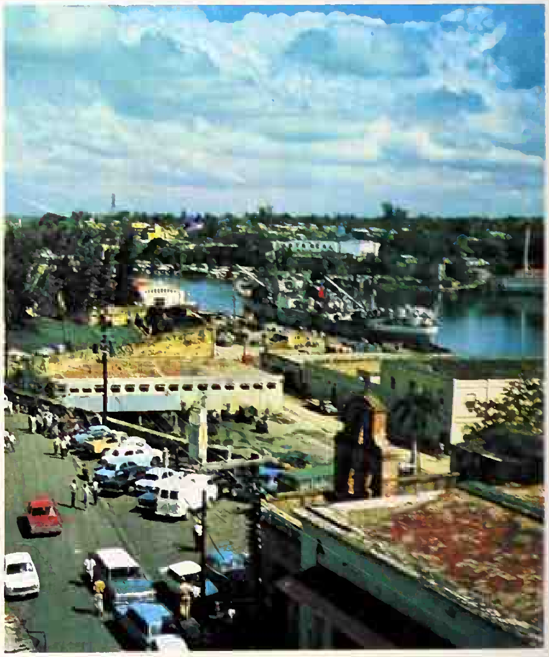
Although the government is attempting to expand industry, most industrial products (and many foodstuffs) must be imported, largely from the United States. Tourism is challenging agriculture as the most important economic sector.

History and Government

In 1492, Christopher COLUMBUS discovered the island of Hispaniola, and it was the site of the first Spanish settlements in the New World. Other New World colonies proved more profitable to the Spanish, however, and Santo Domingo, as the entire colony was called, was neglected. The French began to settle the western end of Hispaniola, and in 1795 the entire island came under French rule. Haiti became an independent nation in 1804, and in 1822 it took over the eastern portion of the island. In 1844 the Spanish-speaking inhabitants of the east rebelled against the Haitians and proclaimed their independence, calling their nation the Dominican Republic.

The new nation experienced severe economic difficulties, and in 1905 the United States established partial control of the Dominican economy to protect American investors there. Increasing debts and internal disorders resulted, in 1916, in the occupation of the country by U.S. Marines. In 1924 the occupation ended. Rafael TRUJILLO came to power in 1930 and established a dicta-

Santo Domingo, the capital of the Dominican Republic, is the oldest continuously occupied European settlement in the Western Hemisphere. It was founded by Christopher Columbus's brother Bartolomé in 1496.



torship that lasted until his assassination in 1961. In December 1962 the first free elections in nearly 40 years brought the leftist Juan Bosch to the presidency. His reform program led to his overthrow by the military in September 1963. When his supporters attempted to restore him to power in 1965, civil war broke out, and U.S. troops were sent in to restore order and the status quo. In 1966, Joaquín Balaguer was elected president. His authoritarian rule, supported by the right wing, continued until the election of 1978, when he was defeated by Antonio Guzmán, who, in turn, was defeated by Salvador Jorge Blanco in 1982.

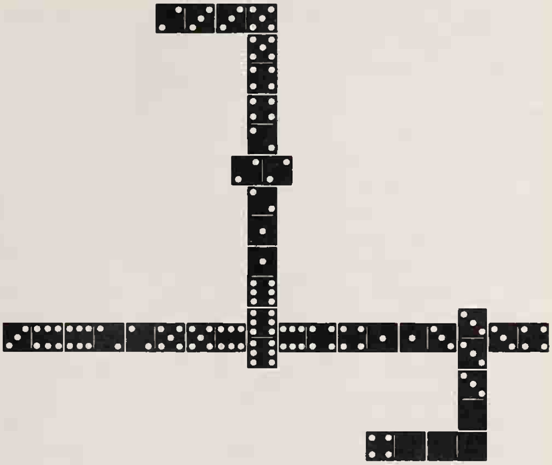
The Dominican economic decline was an ongoing issue in the 1986 and 1990 elections. Balaguer, elderly and blind, narrowly won fourth and fifth terms as president. Ex-president Jorge Blanco was convicted of corruption in 1988; his case was under further consideration in 1989.

Under the constitution of 1966 the government is headed by a president and vice-president elected every four years by universal adult suffrage. The bicameral National Congress comprises a 30-member senate and 120-member chamber of deputies. Its members serve 4-year terms.

Dominicans The Order of Preachers (OP), or Dominicans, was founded (1215) by Saint Dominic during his preaching tours against the Albigenses in southern France. The Dominicans were friars, receiving rigorous theological training in order to preach and answer objections against the Christian faith. They were to be poor and to travel on foot. The first house of friars was established at Toulouse; approval was given by Pope Honorius III. Earlier, Dominic had founded (1206) a community of nuns at Prouille, composed partly of former Albigenses. Later in the century, the Dominican third order began among the laity; it eventually included many communities of nuns who followed the Dominican third order rule.

The Dominicans, who were closely associated with the development of scholasticism during the 13th century, were prominent at the great universities of Europe. Saint Thomas Aquinas was one of their most important representatives. In medieval England, the Dominicans, dressed in a white tunic and scapular with a large black cloak and hood, were called Black Friars. During the Middle Ages they were often chosen to head the Inquisition to track down heretics and bring them to trial.

Domino, Fats Rock 'n' roll progenitor Antoine "Fats" Domino, b. New Orleans, La., May 10, 1929, grew up playing a pounding rhythm-and-blues-style piano and singing in his hometown. Domino's first million-selling record, "The Fat Man," was released in 1949, and he was eventually to record 23 gold singles, most of them during rock 'n' roll's formative years, 1955–60. "Blueberry Hill" (1956) is his most famous recording.



Dominoes, played by two to four players, begins with the double-six piece. All pieces are laid at right angles to this piece and adjacent or perpendicular to each other, in matching suits; the configuration, however, may be altered as the layout nears the table's edge.

dominoes Dominoes is the name of various games played with small rectangular tiles (also called dominoes) made of wood, ivory, bone, or plastic. The face of each tile is divided into two halves, each of which is either marked with dots (called pips) or is blank. The standard domino set has 28 tiles, and each has two values from blank to six, including repetitions, or doublets; they rank from the low double-blank to the high double-six. The basic game can be played by two, three, or four players. The first player lays a tile in the center of the table. Other players try to match halves end to end or, in the case of doublets, perpendicularly, joining the number or blank on one half to a corresponding half. Play continues clockwise as each player adds a tile to either end of the line. Players may pass if they fail to have a match. Games are commonly to 50 or 100 points. The player whose tiles are used up first scores one for each pip on the opponent's unplayed dominoes.

Domitian, Roman Emperor [doh-mish'-uhn] Domitian (Titus Flavius Domitianus), b. Oct. 25, AD 51, d. Sept. 18, 96, was the last Roman emperor of the Flavian dynasty. Though he held no important post during the regimes of his father, Vespasian, and his older brother, Titus, his claim to the throne was not disputed on the death of Titus in 81.

Over the next few years Domitian conducted, with mixed results, several campaigns against tribes beyond the Rhine and Danube rivers. He also sponsored a number of important domestic reforms. However, these achievements were overshadowed by the reign of terror he initiated in 89. Provoked by a rebellion in Germany, Domitian began to attack senators and officials he mistrusted and to suppress even the mildest forms of dissent. Not surprisingly, these autocratic excesses inspired conspiracies of the sort Domitian had feared. He managed to survive most of these, but he was murdered by assassins in the pay of his wife, Domitilla.

Don Cossacks The Don Cossacks were a major group of COSSACKS who settled along the lower Don River in southwestern Russia during the 16th century. Novocherkassk was their capital. Although they swore allegiance to Tsar MICHAEL in 1614, they remained largely independent under the government of their elected ataman. Because of their increased social and economic stratification, the landless Don Cossacks, led by Stenka RAZIN, revolted in 1670–71. A similar revolt led by Kondraty Bulavin in 1707 gave PETER I a pretext for placing the Don Cossacks under close government control. After the revolt of Yemelian PUGACHEV in 1773–75, Empress CATHERINE II, in 1783, incorporated the Cossack units into the regular army regiments.

In the 1800s the Don Cossacks became elite cavalry troops in the Russian army. After the Russian Revolutions of 1917 they sought to reestablish political autonomy and fought on the side of the White Russian armies. The Soviet regime disbanded the Don Cossack army units (they were reconstituted during World War II, however) and, from 1929, broke up their communities through collectivization. Don Cossack life has been described by novelist Mikhail SHOLOKHOV.

Don Giovanni [joh-vahn'-nee] *Don Giovanni*, an opera in two acts by Wolfgang Amadeus MOZART, was first produced in Prague on Oct. 29, 1787. A slightly revised version—with additional numbers—was performed in Vienna the following year. The Italian libretto, by Lorenzo DA PONTE, is based on the DON JUAN legend.

The prototype of aggressive male sexuality, Don Giovanni maintains a catalog, kept by his servant Leporello, listing the numerous women he has seduced. His appeal, however, seems to be fading, for he invades the bedroom of unwilling Donna Anna; when she cries for help, he slays her father, the Commendatore, in a duel. Since Don Giovanni is masked, his identity is unknown for a time; but Donna Anna and her fiancé, Don Ottavio, swear vengeance. Don Giovanni also lavishes his attention on an already betrothed peasant girl and spends much time avoiding Donna Elvira, who loves him. On one of his escapades, he and Leporello are in the cemetery where the Commendatore is buried. The Don jokingly invites the statue of the slain man to dine with him. The statue appears at the Don's villa and urges him to repent—the Don refuses and is dragged down to hell.

Don Giovanni is generally regarded as one of the greatest operatic masterpieces. Its first performance (in German) at the Metropolitan Opera took place on Dec. 10, 1884, with Adolph Robinson in the title role.

Don Juan [dahn hwahn' or joo'-uhn] Don Juan is a legendary figure of Spanish origin (Tirso de Molina's *The Love Rogue* [1630; Eng. trans., 1924]) whose amorous adventures are the subject of many literary and musical works. In the most common form of the legend, Don Juan seduces the daughter of the commander of Seville and later kills her father in a duel. When visiting the father's tomb, he mockingly invites the statue erected over it to a banquet, where the statue comes alive and drags Don Juan off to hell.

Various writers—such as Corneille, Molière, Byron, Shaw, and Rostand—and composers—such as Gluck, Mozart, and Strauss—have offered their own interpretations of the legend. Byron's unfinished epic poem is probably the most famous. His *Don Juan* (1819–24), comprising 16 cantos and part of a 17th in *ottava rima*, is a brilliant satire in which the narration of the protagonist's life serves as a thread to connect the extraordinary range of subject matter in the epic fabric. Byron's seriocomic treatment in verse is among the most highly regarded of English romanticism.

Don Juan, The Teachings of see CASTANEDA, CARLOS

Don Quixote [dahn kee-hoh'-tay] *Don Quixote*, or *El ingenioso hidalgo Don Quijote de la Mancha*, is Miguel de CERVANTES SAAVEDRA's great picaresque Spanish novel and

In this engraving by Gustave Doré, Don Quixote, the title character of Cervantes' classic novel, is dragged from his mount while battling windmills. In the background, Don Quixote's squire, Sancho Panza, bemoans his master's misfortune.

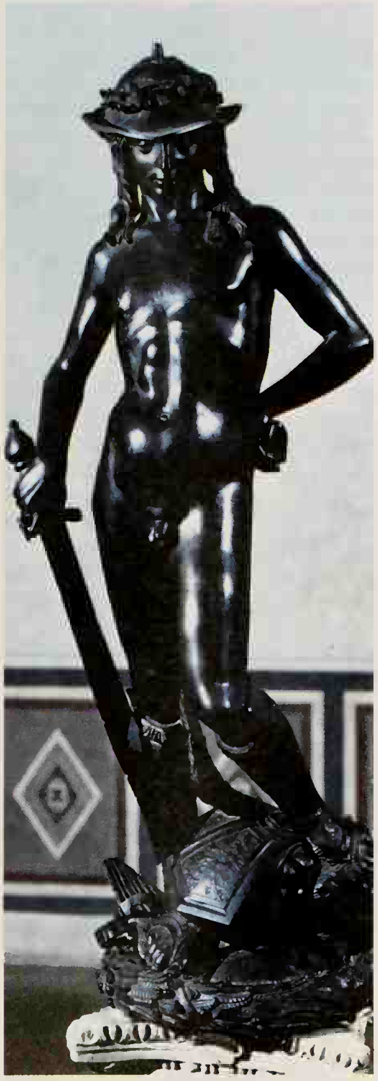
a classic of world satire. Part I was published in 1605 as a burlesque of contemporary chivalric romances, and Part II in 1615 to counteract a plagiarized sequel. The hero, Don Quixote, is a lean, elderly man who, inflamed by a diet of romantic reading, thinks himself a knight-errant and sets out on his emaciated horse, Rosinante, to fight giants, rescue damsels, uplift the oppressed, and court the approval of his so-called lady, Dulcinea del Toboso. Exalting everyone and everything he meets to conform to his chivalric fantasies, he dubs Sancho Panza, the fat peasant who accompanies him on his outdated quest, his squire. After demonstrating his practicality as governor of an island, Sancho Panza longs for the freedom of the road, whereas Quixote, tricked by his friends and a scholar disguised as a knight, returns home and sadly wakens from his magnificent aberrations. The novel served as the model for a popular Broadway musical, *Man of La Mancha* (1965).

Don River The Don River has long been a major transportation artery in the European USSR. It rises in the central Russian uplands near Novomoskovsk and flows generally southward to within 56 km (35 mi) of the Volga River and discharges into the Sea of Azov. Along its 1,900-km (1,200-mi) course, the Don receives many rivers, including the Sosna, Donets, and Chir from the west and the Voronezh, Khoper, Medveditsa, Sal, and Manych from the east. Commercial shipping increased with construction of the Volga-Don Canal in 1952.

Donatello [dohn-ah-tel'-loh] Donato di Niccolò di Betto Bardi, called Donatello, b. 1386?, d. Dec. 13, 1466, was the preeminent genius of early Renaissance sculpture in Florence, Italy. Already practicing by 1406, he worked in every size and medium of sculpture and explored the new humanistic ideas then current in Florence, always balancing a realism based on the study of humanistic nature with an idealism derived from antique sculpture.

As early as the marble *St. Mark* (1411–13; Orsanmichele, Florence) Donatello had rediscovered *contrapposto* (the opposition in a body of contrasted masses) and adapted the drapery to the body's movement. The result is a figure of great organic vitality and unity. From this point on, Donatello sought to characterize his figures as individual personalities rather than as types. In the marble *St. George* (*c.*1415–17; Bargello, Florence; made originally for Orsanmichele) Donatello slightly twisted the saint's body and intensified the face to present a proud, youthful, self-confident hero, a Renaissance ideal. In the relief at the base, *St. George and the Dragon*, his virtuosity is shown by the *rilievo schiacciato* ("crushed" or "flattened" relief), in which the field of action seems deep but the sculptural plane is actually extremely shallow. Donatello's accomplishment in such reliefs is fully realized in his gilt bronze *Herod's Feast* (*c.*1425; Baptistery of San Giovanni, Siena).

In the *Prophets* (begun in 1416) that he made for niches in the campanile of the Florence Cathedral, Donatello experimented increasingly with a harsh realism that was exaggerated in part to compensate for the eroding effects of distance and daylight. Perhaps about 1425, according to a recent theory, the city of Florence commissioned the famous bronze *David* (Bargello, Florence); the nude figure gazes down on the head of a Goliath who wears a winged helmet, a device of the Visconti family of Milan. In this work Donatello created probably the first free-standing bronze nude since antiquity, and the adolescent's slim sinuosity, his nudity emphasized by hat, sword, and greaves, symbolizes another Renaissance ideal, physical grace and beauty.



Donatello's famous bronze, David *(c.1430–32), was the first life-size, free-standing, nude statue since classical antiquity. This figure of the adolescent boy hero is among the greatest achievements of Early Renaissance sculpture. (Bargello, Florence.)*

From the 1420s until his death Donatello and his shop produced numerous works, especially in Florence, Siena, and Padua. In the equestrian statue of Erasmo da

Narni, whose nickname was Il Gattamelata, "honeyed Cat" (*c.*1445–50; Piazza del Santo, Padua), Donatello, using the sole surviving ancient Roman equestrian, the *Marcus Aurelius* (Campidoglio, Rome), as a model, reinvented the mode of presenting a great general. He elevated the group on a high base, made the rider and horse convincingly proportionate to each other, and gave the rider an alert and commanding energy.

In his late works Donatello often developed a kind of neo-Gothic harshness and expressive realism, as in his wood sculpture *Mary Magdalen* (*c.*1454–55; Baptistery, Florence).

Donatists [dahn'-uh-tists] The Donatists were followers of Donatus the Great, a 4th-century theologian and bishop of Carthage. They brought about a schism in the Christian church of North Africa over the ordination of their bishop. Under the leadership of Donatus, they flourished from 311 to 373.

The Donatists taught that only the sinless could belong to the true church, that sacraments conferred by sinful ministers were invalid, and that only baptism conferred by a Donatist was valid. Saint AUGUSTINE refuted their doctrines. Their teachings were also condemned by the Synod of Rome (313) and by the Synod of Arles (314). The Donatists were conquered by the Vandals in 430 and finally disappeared with the Muslim Arab invasion of North Africa in 637.

Doncaster Doncaster (1987 est. pop., 290,000), a town in South Yorkshire (see YORKSHIRE) in northern England, is situated on the River Don about 72 km (45 mi) east of Manchester. Industries include coal mining, agricultural machinery, electrical equipment, and textile manufacturing. Doncaster is the commercial center for the surrounding agricultural and mining region. It is known for the St. Leger Stakes, a famous horse race first run in 1776. St. George's Church (1854) was designed by George Gilbert Scott. A Roman military camp called Danum was established on the site of the city in the 1st century AD.

Donegal [dahn'-i-gawl] Donegal (Irish: Dún Na nGall), the northernmost county of Ireland, lies along the Atlantic coast. The population is 129,664 (1986), and the area is 4,830 km^2 (1,865 mi^2). Lifford is the county town. Donegal is primarily mountainous, reaching 752 m (2,466 ft) at Errigal Mountain. Most of the population live along the coast and in the river valleys, where they grow potatoes and oats. Fishing, tourism, and stock raising are also important. Tweeds and other textiles are the principal products of the towns. Irish is still spoken in the mountainous areas. Known as Tyrconnell in ancient times, Donegal was long ruled by the O'Donnell family and was one of the last parts of Ireland to come under English rule (1603). Although part of the province of ULSTER, it was awarded to the Irish Free State (later the Republic of Ireland) in the partition of 1920–22.

Donelson, Fort see FORT HENRY AND FORT DONELSON

Donets Basin [duhn-yets'] The Donets Basin, or Donbas, is a major coal-producing region and heavy industrial center in the Ukrainian republic of the USSR. Some 26,000 km^2 (10,000 mi^2) in area, it is situated in the Azov Uplands between the Don and Dnieper rivers. Most of the basin lies in the Donetsk and Voroshilovgrad oblasts, and it is traversed by the Donets, a tributary of the Don.

The basin is the USSR's largest single producer of high-grade coal and its major source of coking coal. Its proximity to the rich Krivoi Rog iron fields has spurred its growth as an important steel center. The basin also has salt, mercury, gas, lime, and sand resources. It is heavily developed, with iron, steel, chemical, glass, heavy-machinery, and power industries. The many cities in the area include Donetsk, Makeyevka, Gorlovka, and Yenakiyevo.

Donetsk [duhn-yetsk'] Donetsk is the capital of Donetsk oblast of the Ukrainian republic of the USSR. The population is 1,110,000 (1989 est.). It is situated in the DONETS BASIN in the southeastern Ukraine, and is the largest coal-mining and steel center there, with chemical plants and machinery manufacturing. The city has a university and several polytechnical institutes. Donetsk was founded in 1870 as the town of Yuzovka, named for Yuz, a phonetic rendering of John Hughes, a Scottish industrialist who owned the local steel plant. In the Soviet period, it was named Stalino in 1924 but lost that name in 1961 at the time of Nikita S. Khrushchev's de-Stalinization campaign. It was then named Donetsk, for the Donets Basin. The city was occupied (1941–44) by the Germans during World War II.

Dong Qichang (Tung Ch'i-ch'ang) [doon chee chang] Dong Qichang, b. Feb. 10, 1555, d. 1636, was an important Chinese scholar-painter and the most influential writer on the theory of painting in the late Ming period. Dong's painting opened up a new direction for such later artists as the Four Wangs (see WANGS, FOUR) of the Qing dynasty. Instead of the naturalism preferred by his contemporaries, Dong was interested in the formal structure of the picture and stressed the importance of studying the ancient models and calligraphy. As an art theorist, he divided previous Chinese painters into two groups, which he called the Notheren and Southern schools. His advocacy of the Southern school, and particularly the four Yuan masters, had a long-lasting influence on later aestheticians.

Dongen, Keesvan [dawng'-uhn, kaysfahn] Cornelius Theodorus Marie (Kees) van Dongen, b. Jan. 26, 1877, d. May 28, 1968, was a Dutch painter and a major member of the Fauve group (see FAUVISM). Van Dongen's early works were inspired by the impressionist painters and by Vincent van Gogh. After 1906 he developed a Fauve style in which vivid colors, bold outlines, simplified forms, and emotional distortions express his passionate involvement with the Bohemian life of Paris, as in his canvas *Fathma and Her Troupe* (1905–07; B. J. Fisz Collection, Paris). His paintings, often of women with brilliantly painted red lips and huge eyes, are unabashedly sensual—for example, *Modjesko Soprano Singer* (1908; Museum of Modern Art, New York City). After 1918 van Dongen became a popular society painter, and his style grew more realistic.

Dönitz, Karl see DOENITZ, KARL

Donizetti, Gaetano [doh-ni-tset'-ee, gy-tah'-noh] Gaetano Donizetti, b. Nov. 29, 1797, d. Apr. 8, 1848, was one of the great masters of 19th-century Italian opera. In 1822 he enjoyed a tremendous success with the production of *Zoraide di Granata* in Rome. His first enduring opera, however, was *Anna Bolena*, which had its premiere in Milan (1830). For a short time he was a professor at (then director of) the Conservatorio di San Pietro a Maiella in Milan. Widely traveled, he made successful visits to Paris, Vienna, and several other cities. Donizetti was a prolific composer, and his international fame grew. In 1845, at the height of his career, he developed a brain tumor that led to depression, paralysis, and periods of insanity. After spending some time in an asylum outside Paris, he died in his native Bergamo.

A brilliant composer of both tragic and comic opera, Donizetti was a master of vocal effect and dramatic situation. He often used historical subjects for his operas, and drew heavily from the writings of Sir Walter Scott, as in his most popular opera, *Lucia di Lammermoor* (1835). His masterpieces of comic opera are *L'Elisir d'amore* (The Love Potion, 1832) and *Don Pasquale* (1842). Although he wrote most of his operas in Italian, he also set French texts for Paris, such as *La Fille du régiment* (The Daughter of the Regiment) and *La Favorite* (both 1840). Donizetti wrote about 70 operas, and his prolific output also includes symphonies, chamber music, piano works, songs, cantatas, oratorios, and masses (including a requiem on the death of Vincenzo Bellini).

Gaetano Donizetti, a 19th-century Italian composer, produced more than 60 operas in addition to sacred and instrumental music. Enormously popular for both comic and serious opera, Donizetti is best known today for such works as Lucia di Lammermoor *(1835) and* Don Pasquale *(1842).*

donkey The donkey, or burro, is a hoofed, herbivorous mammal belonging to the family Equidae, order Perissodactyla. It is the domesticated variety of the ASS, *Equus asinus asinus*. The donkey is related to the horse, and, although smaller, it is capable of carrying a full-sized human over a considerable distance. Often mistaken for the MULE, which is the sterile hybrid offspring of the ass and the horse, the donkey is physically similar to the mule, having long ears, a tufted tail, slender legs, small hooves, and a loud bray.

Donleavy, J. P. [duhn'-lee-vee] James Patrick Donleavy, b. Brooklyn, N.Y., Apr. 23, 1926, is an American fiction writer and playwright who helped introduce the vogue of BLACK HUMOR in fiction with his novel *The Ginger Man* (1955; play, 1959). Educated at Trinity College, Dublin, Donleavy has lived most of his adult life in Ireland. His fiction and plays portray life as alternately comic, tragic, lusty, squalid, and absurd. His anti-heroes and fragmented style portray a world that is hilariously askew. Donleavy has also written *A Singular Man* (1963; play, 1964), *The Onion Eaters* (1971), *A Fairy Tale of New York* (1973), and *J. P. Donleavy's Ireland* (1986).

J. P. Donleavy, an American-born novelist who has become an Irish citizen, is best known for his first novel, The Ginger Man *(1955), which he adapted for the stage in 1959. Donleavy has been influential in the development of black humor in American literature.*

John Donne, the first of the great metaphysical poets, lived the life of a courtier before converting to Anglicanism and achieving fame as a preacher. Donne's sophisticated poetry has appealed strongly to 20th-century readers.

Donne, John [duhn] John Donne, b. London, 1572, d. Mar. 31, 1631, was the most outstanding of the English metaphysical poets (see METAPHYSICAL POETRY) and a churchman famous for his spellbinding sermons.

Born to a prominent Roman Catholic family but converted to Anglicanism during the 1590s, Donne was educated at Oxford and Cambridge. Having become a member of Thavies Inn (1591) and Lincoln's Inn (1592), he seemed destined for a legal or diplomatic career. He joined the earl of Essex's military expedition to Spain (1596) and the Azores (1597) and between 1598 and 1601 served as secretary to Sir Thomas Egerton, Lord Keeper of the Great Seal. His secret marriage (1601) to Egerton's niece, Anne More, so angered her father that he disinherited the pair and had Donne briefly imprisoned (1602). The poet, in a characteristic pun, later summed up the experience: "John Donne, Anne Donne, Undone." After ordination in the Anglican church in 1615, he became chaplain to James I, and in 1621 was named dean of St. Paul's Cathedral.

Donne's poetry embraces a wide range of secular and religious subjects. He wrote cynical verse about inconstancy (for example, "Go and catch a falling star" and "I can love both fair and brown"); poems about true love, such as "The Good-Morrow" and "Sweetest love, I do not go/For weariness of thee"; Neoplatonic lyrics on the mystical union of lovers' souls and bodies, such as "Air and Angels" and "The Ecstasy"; brilliant satires; hymns and holy sonnets depicting his own spiritual struggles, such as "A Hymn to God the Father," "Batter my heart, three-personed God," and "I am a little world made cunningly," in which he begs God to purge him of sin. The two *Anniversaries*—"An Anatomy of the World" (1611) and "Of the Progress of the Soul" (1612)—are elegies for 15-year-old Elizabeth Drury, whose death epitomized for Donne the decay of the world, physically and morally, and whose entry into heaven heralded its potential regeneration.

Except for the *Anniversaries*, nearly all Donne's poems were published posthumously and cannot be dated. Whatever the subject, they reveal the characteristics of the metaphysical poets: dazzling wordplay, often explicitly sexual; paradox; subtle argumentation; surprising contrasts; intricate psychological analysis; and striking imagery from nontraditional areas such as law, physiology, scholastic philosophy, and mathematics. ("A Valediction: Forbidding Mourning" contains the famous conceit comparing lovers' souls to the legs of a compass.) Samuel Johnson disapproved, for "the most heterogeneous ideas are yoked by violence together." But T. S. Eliot praised Donne and his followers for achieving a "unification of sensibility."

Donne's prose, almost equally metaphysical, ranks at least as high as his poetry. The *Sermons*, about 160 in all, are especially memorable for their imaginative explications of biblical passages and for their intense explorations of divine love and of the decay and resurrection of the body. *Paradoxes and Problems* (*c.*1598) is a collection of playful demonstrations (for example, "A Defence of Women's Inconstancy" and "Why Puritans Make Long Sermons"). *Biathanatos* (*c.*1608) is a half-serious extenuation of suicides.

Devotions upon Emergent Occasions (1624) is a powerful series of meditations, expostulations, and prayers in which Donne's serious sickness at the time becomes a microcosm wherein can be observed the stages of the world's spiritual disease. The work includes the celebrated reflection on the meaning of a distant funeral bell: "No man is an island entire of itself. Any man's death diminishes me, because I am involved in mankind, and therefore never send to know for whom the bell tolls; it tolls for thee." Donne was fully prepared for his own death. Having left his sickbed to deliver his last sermon, fittingly entitled "Death's Duel," he then returned home to pose for his portrait in a funeral shroud. He died a month later.

Donner party [dahn'-ur] The Donner party suffered one of the most terrible and famous tragedies in the history of the American West. Organized in Illinois in 1846 by Jacob and George Donner, a group of 87 persons chose to follow an untested route to California and began the difficult crossing of the Sierra Nevadas in late October. Within a week they were snowbound high in the mountains. In mid-December 17 set out to bring help. Of these, 7 reached California and sent back rescue parties, but not before many of those remaining had starved to death and others had resorted to cannibalism. Of the original number, only 47 survived.

Donner Pass At an altitude of 2,160 m (7,089 ft), the Donner Pass is located in the SIERRA NEVADA in northern California, 56 km (35 mi) southwest of Reno, Nev. It was named for the Donner party, which lost 40 of its members as it attempted to cross the pass during the winter of 1846–47. The pass, now within the Tahoe National Forest, is crossed by a highway. The Norden railroad tunnel is located under the summit of the pass.

Dooley, Mr. see DUNNE, FINLEY PETER

Dooley, Thomas Thomas Anthony Dooley, b. St. Louis, Mo., Jan. 17, 1927, d. Jan. 18, 1961, a physician and author, was widely known as the "jungle doctor" because of his efforts to supply medical care to underdeveloped countries of Southeast Asia. As a U.S. Navy medical officer, he established public health measures during the evacuation of North Vietnam in 1954. In *Deliver Us from Evil* (1956), Dooley described this work. With the royalties from the book, he established a hospital in Laos. He also founded MEDICO, an organization that provides needy countries with medical and hospital facilities.

Doolittle, Hilda Known as H. D., Hilda Doolittle, b. Bethlehem, Pa., Sept. 10, 1886, d. Sept. 29, 1961, was an American poet, translator, and novelist, who gained recognition through her early imagist poems. In 1911 she moved to England, where she married the poet-novelist Richard Aldington and came under the influence of Ezra POUND and IMAGISM. Her poems "Heat" and "Oread" are prime examples of the precise images, economical language, and freedom of form of imagism. Like others involved in that movement, H. D. passed through this period to find a new style, utilizing classical Greek myths and exploring archetypes. Her collections of poetry include *Sea Garden* (1944), *Collected Poems* (1925, 1940), *The Walls Do Not Fall* (1944), and *Helen in Egypt* (1961). Her prose includes *Tribute to Freud* (1956), about her own psychoanalysis, and the fictional *Palimpsest* (1926), *Hedylus* (1928), and *Bid Me Live* (1960), which is autobiographical.

Doolittle, James James Harold Doolittle, b. Alameda, Calif., Dec. 14, 1896, was a U.S. airman who led the first bombing raid over Tokyo (April 18, 1942) in World War II. A pilot instructor in World War I, he became the first man to fly across North America within 24 hours in 1922 and was subsequently known as a racing pilot. Later in World War II he commanded U.S. air forces in North Africa and Europe.

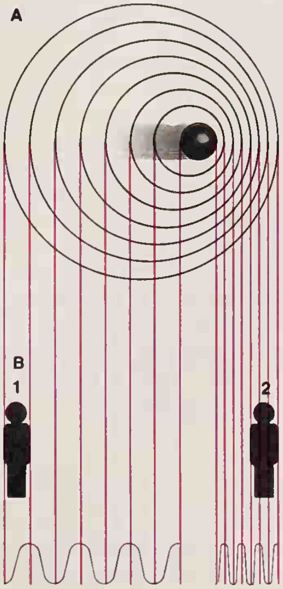
Doors, The The Doors, 1965–73, were an American rock group whose dark lyrics, electric-blues musicianship, and charisma inspired a large following. Consisting of seductive lead singer Jim Morrison, keyboardist Ray Manzarek, guitarist Robby Krieger, and drummer John Densmore, the group took its name from Aldous Huxley's *The Doors of Perception* (1954), on the use of mescaline as a mind-altering drug. Their first album, *The Doors* (1967), became a number-one record, as did one of its songs, "Light My Fire." *Strange Days* (1967), *Waiting for the Sun* (1968), *The Soft Parade* (1969), and *L.A. Woman* (1971) also sold very well. Morrison died in Paris on July 3, 1971.

Doppler effect When a source of sound moves toward or away from a listener, the pitch, or frequency of the sound, is higher or lower than when the source is at rest. A common example is the rise and fall of the pitch of a locomotive whistle as it approaches and recedes from the listener. Similar results are obtained when the listener approaches or recedes from a stationary sound source. This phenomenon, the Doppler effect, applies to all types of waves and is named for Christian Johann Doppler, an Austrian scientist who predicted in 1842 that the color of a luminous body would change in a similar manner, due to the relative motion of the body and the observer.

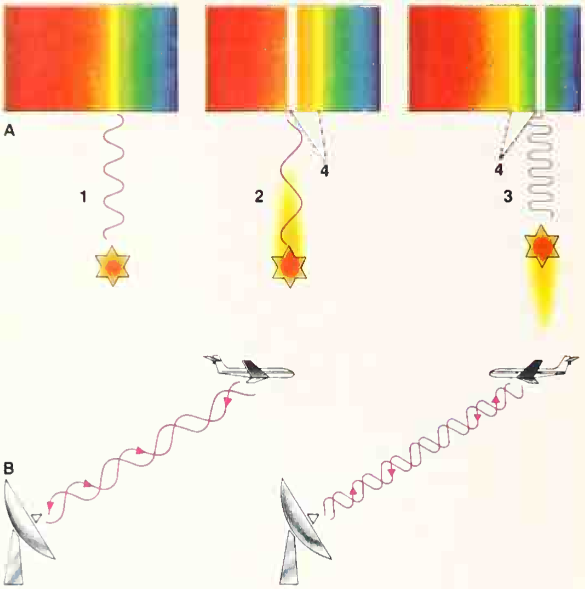
Simply stated, the Doppler effect works this way: when a source of sound approaches the listener, the waves in front of the source are crowded together so that the listener receives a larger number of waves in the same time than would have been received from a stationary source. This process raises the pitch that the listener hears. Similarly, when the source moves away from the listener, the waves spread farther apart and the observer receives fewer waves per unit of time, resulting in a lower pitch.

Because the velocity of light is so great, Doppler effects can be observed only for astronomical or atomic bodies with velocities that are large compared to ordinary speeds, as in the shift in the wavelengths of light emitted by moving astronomical bodies. The shift to longer wavelengths of light (see RED SHIFT) from distant galaxies indicates that they are receding and supports the concept of an expanding universe. Radiation from hot gases shows a spread of wavelengths, because the emitting atoms or molecules move at varying speeds in different directions as measured by the observing instrument.

The Doppler effect has many uses in science and a variety of practical applications as well. Measurements of



The Doppler effect is a change in the observed frequency of sound or light resulting from the motion of a source or of an observer. Successive wave crests emitted by a stationary source (A) in all directions approach any stationary observer at a constant distance, or wavelength, behind each other and at a constant frequency. An observer moving toward the source encounters more wave crests, or a higher frequency, whereas an observer moving away notes fewer crests, or a lower wave frequency. If the source (B) moves away from an observer at position 1, the waves seem to be drawn out to longer wavelengths and are received at a lower frequency. If the source approaches observer 2, the waves are crowded together; they appear shorter in wavelength and follow each other at a higher frequency.



The movement of a star (A) *is revealed by a Doppler change in wavelength, or shift, of its spectral lines. The observed wavelength of a spectral line* (1) *is normal for a star that is stationary with respect to Earth; it is lengthened, or red shifted* (2), *for a receding star and is shortened, or blue shifted* (3), *for an approaching star. The amount of shift* (4) *indicates the star's speed. On Earth, an aircraft's speed and direction of motion* (B) *are found by comparing the length of a transmitted radar wave with that reflected by the aircraft.*

shifts of radio waves from orbiting satellites, for example, are used in maritime NAVIGATION, and the effect is also employed in the RADAR surveillance of automobile speeds. Medically, the effect is used in such techniques as ultrasonography, or the study of motions in deep-lying body structures, and echocardiography, or the study of heart motions (see RADIOLOGY). Such techniques make use of ULTRASONIC waves, or very high-speed sound waves.

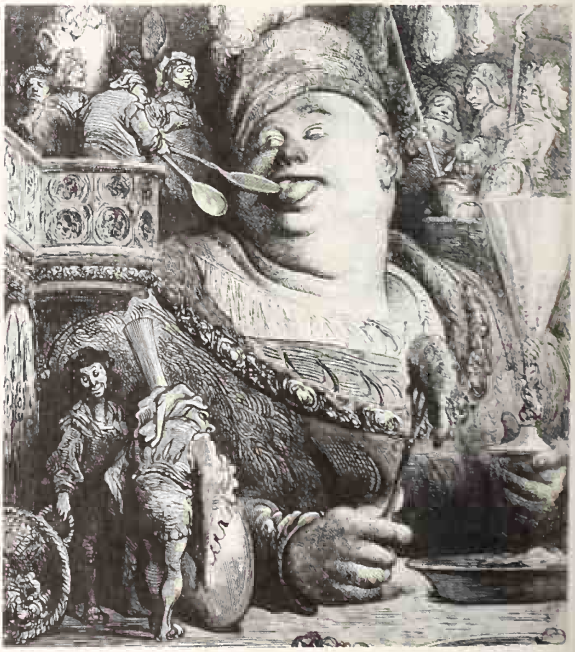
Dorati, Antal [doh-rah'-tee, ahn-tahl'] Antal Dorati, b. Apr. 9, 1906, d. Nov. 13, 1988, was a Hungarian-American conductor and composer, celebrated for his ability to train orchestras and for his championing of modern music. He was conductor with the Ballets Russes de Monte Carlo (1933–41), and in 1941–45 guided the new American Ballet Theatre as its musical director. Principal conductor with the Minneapolis, Stockholm, and Detroit orchestras, and with London's Royal Philharmonic, Dorati also composed orchestral and vocal works. His autobiography, *Notes of Seven Decades*, was published in 1979.

Dordrecht [dor'-drekt] Dordrecht (sometimes called Dort or Dordt) is a port city in the southwestern Netherlands, about 15 km (9 mi) southeast of Rotterdam. Its population is 107,871 (1988 est.). Shipbuilding and chemical and metallurgical industries are important. The city's 14th-century Gothic church is well known.

Founded in the 11th century, Dordrecht was the residence of the counts of Holland until 1203 and a member of the Hanseatic League. Rebels took the city in 1572 during the Dutch Revolt against Spanish rule, and the first assembly of the independent United Provinces met there the same year.

Doré, Gustave [dor-ay', goos-tahv'] The French artist Gustave Doré, b. Jan. 6, 1832, d. Jan. 23, 1883, one of the great illustrators of the 19th century, is best known for his imaginative and fantastic wood-engraved book illustrations. He displayed his natural talent for drawing at an early age and in 1847 was taken to Paris by his parents. There, Doré became acquainted with Charles Philipon, the publisher of the *Journal pour Rire*. He produced weekly lithographic cartoons for Philipon over the next three years while he continued his education at the Lycée Charlemagne. His education also included regular visits to the Louvre and the print department of the Bibliothèque Nationale. The opportunity to break away from caricature came when Doré was commissioned by Paul Lacroix to produce wood engravings for a book of his collected works. In 1854, Doré began a series of illustrated classics starting with the works of François Rabelais, fol-

Gustave Doré's woodcut Gargantua *appeared in his 1854 edition of the works of Rabelais, the first of a series of illustrated classics that were to bring the artist fame. Doré's vivid compositions had a lasting impact on the art of book illustration.*



lowed by Honoré de Balzac's *Contes Drolatiques* (1855), Dante's *Inferno* (1861), Cervantes's *Don Quixote* (1863), *The Bible* (1866), and John Milton's *Paradise Lost* (1866). Doré conceived of the idea of publishing illustrated editions of literary masterpieces in folio format. The first of these editions was Dante's *Inferno*, published at Doré's own expense and with resounding success.

Doré worked with incredible speed, drawing directly on the woodblock, which was then cut by a staff of engravers specially trained by the master. Variations in the density of the cut lines came close to simulating the tonal effects of brushstrokes. Doré's power of visualization and dramatization caught the essence of his subjects whether they were secular or religious. He tried his hand at oil painting and, to a lesser extent, sculpture, but without the success of his graphic work.

Doria, Andrea [dor'-ee-ah, ahn-dray'-ah] Andrea Doria, b. Nov. 30, 1466, d. Nov. 25, 1560, was Genoa's greatest statesman, soldier, and admiral of the Renaissance. During the ITALIAN WARS he served under Pope Innocent VIII and Kings Ferdinand I and Alfonso II of Naples. He led the Genoese navy against the Barbary pirates and defeated the Ottoman Turks at Pianese in 1519. Doria later changed allegiance from King FRANCIS I of France to Holy Roman Emperor CHARLES V, who helped him retake Genoa from the French in 1528.

Named for Doria was the Italian ocean liner *Andrea Doria*, which on July 25, 1956, sank off the Massachusetts coast after colliding in fog with the Swedish liner *Stockholm*. Fifty-two lives were lost.

Dorians [dor'-ee-uhnz] The Dorians were a Greek-speaking people, classified by their dialect, who migrated into Greece after 1200 BC by way of Illyria, Epirus, and northeastern Macedonia. Their use of the iron sword may have helped bring an end to the more advanced AEGEAN CIVILIZATION of the Mycenaeans. Dorians settled in Crete and in much of the Peloponnesus. Later they colonized some of the Aegean islands, southeastern Asia Minor, and the island of Rhodes. The Dorians themselves considered Doris, north of modern Amfissa in central Greece, their homeland.

Dorion, Sir Antoine Aimé [dor-yohn'] Sir Antoine Aimé Dorion, b. Sainte-Anne-de la Pérade, Lower Canada (Quebec), Jan. 17, 1818, d. May 31, 1891, was twice copremier of Canada (1858, 1863–64). He was elected to the Legislative Assembly in 1854, serving there and (after 1867) in the Canadian House of Commons almost continuously until 1874. His first copremiership, with George BROWN in 1858, lasted only three days, but he held the office again with John Sandfield MACDONALD (1863–64). Initially an opponent of confederation, Dorion eventually joined Alexander MACKENZIE's Liberal government as minister of justice (1873–74). From 1874 he was chief justice of Quebec.

dormancy [dor'-muhn-see] Dormancy is a state of reduced physiological, or metabolic, activity in organisms. It may be regarded as a mechanism enabling them to survive unfavorable periods. Dormancy in plants is discussed here. For animals, see HIBERNATION.

Many factors are involved in dormancy; environmental features, such as temperature, light, and moisture, may interact with internal factors to induce or to break dormancy. Dormancy may affect the entire plant or just parts of it. It may occur sporadically, or, more often, it may be a regular phase in a plant's life. Two regularly occurring types of dormancy are those affecting seeds and buds.

The major internal factors in seed dormancy are the seed coat, chemical inhibitors, and the embryo. The seed coat may maintain dormancy and prevent growth by blocking the passage of water or oxygen to the embryo or by physically preventing the embryo from enlarging. The seed coat must rot or weaken before germination can occur.

Chemical growth inhibitors may be present in the seed coat or other parts of the seed. These chemical inhibitors must be leached from the seed by water, or the tissues containing them must be destroyed before growth can occur.

The embryos of most seed plants are not self-dormant and will grow unless prevented from doing so by the seed coat or by inhibitors. Some embryos, however, are dormant and must pass through an after-ripening process, which is not clearly understood, before growth can occur. Another form of embryo dormancy is that due to the immaturity of the embryo itself; germination must await its full development.

Environmental factors that affect dormancy include temperature, light, and moisture. The seeds of many cold-region plants will not germinate unless exposed to freezing or to a period of low temperatures. The presence or absence of light (or of light of specific wavelength) may exert an effect, as can the presence or absence or quality of moisture.

Overwintering leaf buds, containing some or all of the next season's leaves in an embryonic state, are produced by many temperate-region trees and shrubs. In spring the bud scales open and the bud shoot and leaves renew growth. After a time, spring growth ceases, new overwintering buds are produced, and a new cycle begins. The ending of spring growth and the formation of buds is promoted by a number of factors, among them cheminhibitors, similar to those involved in seed dormancy, and photoperiod, or length of daylight.

To break bud dormancy, factors such as an increase in photoperiod, a chilling period, or an increase in growth hormones (auxins, gibberellins, cytokinins)—or a combination of these—may be required.

dormouse Dormouse is the common name of several species of rodents belonging to the family Myoxidae. Dormice are 5 to 19 cm (2 to 7.5 in) long, with a tail 40 to 165 mm (1.5 to 6.5 in) long. Dormice resemble small squirrels and are found in Eurasia and Africa. They fatten

The common or fat dormouse looks for food by night and dozes in a tree during the day. It has a reputation for being one of the sleepiest of all animals.

in summer and stay dormant in winter. Litters number two to nine.

Dorr's Rebellion Dorr's Rebellion was an uprising in Rhode Island in 1842 to secure constitutional reform. At that time the state was still governed under the terms of the 1663 colonial charter, which restricted voting rights to male property owners. In 1841 a reform movement began, led by Thomas Wilson Dorr (1805–54). Dorr called a convention (October 1841) that drafted a constitution based on universal male suffrage. Although the government ruled Dorr's constitution illegal, his party nonetheless held elections, and as a result, Dorr proclaimed himself governor in April 1842. The official government then declared martial law, and after some armed clashes Dorr fled the state. Later sentenced (1844) to life imprisonment, he was released after one year.

Dorset Dorset (also called Dorsetshire) is a county in southwestern England on the English Channel. The population is 655,700 (1988 est.), and the area is 2,655 km^2 (1,025 mi^2). Dorchester is the county town. Chalk downs are found in the western portion of Dorset, but the rest of the county is composed of lowlands drained by the rivers Avon, Trent, Frome, and Stour. Agriculture is the primary economic activity; grains and beans are grown, and dairy cattle and sheep are raised. The coastal resorts such as BOURNEMOUTH and Weymouth and the many prehistoric remains, particularly MAIDEN CASTLE, are at the heart of the important tourist industry. Poole is the major port and manufacturing center. By the 2d century BC, Dorset was the home of the Durotrige tribe, and during the 1st century AD it became a Roman province. In the 7th century it was incorporated into the Anglo-Saxon kingdom of Wessex. Dorset was the setting for the novels of Thomas Hardy.

Dorsey, Jimmy and Tommy The Dorsey brothers each led popular SWING era bands. James, b. Shenandoah, Pa., Feb. 29, 1904, d. June 12, 1957, was best known for his work on clarinet; Thomas, b. Shenandoah, Pa., Nov. 19, 1905, d. Nov. 26, 1956, was a renowned trombonist. The brothers shared a single band for short periods (1933–35, 1953–56), but the separate Dorsey bands achieved national prominence. Although the Dorseys did not exert an important influence on jazz style, both bands were noted for their fine arrangements and ensemble work, and featured many top-ranked soloists of the 1930s and '40s.

Dortmund [dort'-munt] Dortmund, a city in northwestern Germany, is a transportation and industrial center with a population of 568,200 (1987). It is in the state of North Rhine-Westphalia and is located on the Dortmund-Ems Canal, east of Essen. Dortmund has large steel and iron works and breweries. Largely destroyed during World War II, Dortmund has been rebuilt and restored. The Westfalenhalle (Westphalia Hall), built in 1952, is one of Europe's largest convention halls and is considered a modern landmark. Dortmund is the site of many educational facilities, including a university.

First mentioned in the late 9th century, Dortmund became an imperial free city in 1220. Shortly thereafter it joined the Hanseatic League and became an important trade center. The city declined steadily after the Thirty Years' War (ended 1648), and lost imperial rights in 1803. In the 19th century the development of mining and the opening (1899) of the canal encouraged the city's growth.

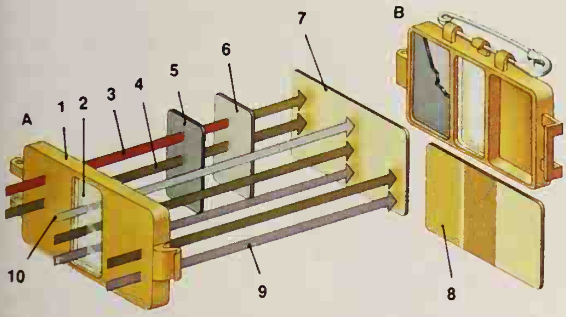
Dos Passos, John [duhs pas'-uhs] The American novelist John Dos Passos, b. Chicago, Jan. 14, 1896, d. Sept. 28, 1970, was a major figure in post–World War I literature. His epic trilogy *U.S.A.*, consisting of *The 42nd Parallel* (1930), *1919* (1932), and *The Big Money* (1936), is a radical critique of American life and a top contender for the title of "the great American novel" (see U.S.A.).

Dos Passos, who was of Portuguese descent, graduated from Harvard in 1916 and volunteered as an ambulance driver in World War I. His first published novels, *One Man's Initiation—1917* (1919) and *Three Soldiers* (1921), recount the bitter war years and earned him recognition as a chief spokesman for the LOST GENERATION. His social sympathies were combined with experimental narrative techniques in his first major novel, *Manhattan Transfer* (1925), which anticipates the stylistic innovations of *U.S.A.*

John Dos Passos, an American novelist, developed a fictional style incorporating several documentary devices to lend realism to his works. In his most notable achievement, the trilogy U.S.A., *Dos Passos chronicled what he perceived to be a disintegration of American social values as a consequence of 20th-century industrialism.*

Embittered by his observations of the Spanish Civil War, Dos Passos became disillusioned with radical liberalism and adopted a more conservative position in his *District of Columbia* trilogy: *Adventures of a Young Man* (1939), about the Spanish Civil War; *Number One* (1943), about a Southern demagogue resembling Huey Long; and *The Grand Design* (1949). He became increasingly conservative, and his later works called for a return to the values of America's founding fathers. The novel *Midcentury* (1961) was favorably received. In 1966 he published a book of memoirs, *The Best Times.*

dosimeter [doh-sim'-et-ur] A dosimeter, a device for determining exposure to nuclear radiation, is often in the form of a badge worn by persons in suspect areas. Integrating dosimeters are also permanently mounted in suspected high-radiation areas and checked at frequent intervals. Dosimeters function by using the long-term effects of radiation upon some phenomenon that can be reliably measured. Photographic film emulsions, for example, are sensitive to radiation, which changes the film density. Because such film badges are inexpensive, simple to make, lightweight, and reasonably accurate, they are widely used for monitoring personnel. A small device known as an electroscope may also be used. For the units used in measuring human exposure to radioactivity, see rad and rem.



Total exposure to nuclear radiation is determined by observing the variable blackening of photographic film (7) *in a dosimeter—usually in the form of a film badge* (B, shown disassembled in A)*—and comparing the film with laboratory standards. Gamma rays* (4) *pass through all materials and expose all sections of the film. Neutrons* (3), *which do not affect the film directly, are detected only by one section* (8) *of the film after they pass through a lead filter* (5) *to slow them down so they can be absorbed by a cadmium filter* (6). *A gamma ray is emitted for each neutron absorbed. X-rays* (9) *are blocked by the lead filter and blacken only two-thirds of the film. Beta radiation* (10) *blackens only one-third of the film; absorbed by the plastic holder* (1), *it passes only through the window* (2).

Dostoyevsky, Fyodor Mikhailovich [duhs-tuhyef'-skee, fee-oh'-dor mee-ky'-loh-vich] The Russian novelist Fyodor Mikhailovich Dostoyevsky, b. Nov. 11 (N.S.), 1821, d. Feb. 9 (N.S.), 1881, stands at the very summit of Russian literature and is considered by many to have brought the Western novel to the peak of its possibilities. Sigmund Freud, for one, considered the treatment of patricide in The Brothers Karamazov the equal of that of Shakespeare in *Hamlet* and of Sophocles in *Oedipus Rex*, while Jean Paul Sartre has said that all of French existentialism is to be found in Ivan Karamazov's contention that if there is no God, everything is permitted.

Russian novelist Fyodor Dostoyevsky probed the complexities of the human heart in his masterpieces Crime and Punishment *(1866) and* The Brothers Karamazov *(1879–80).*

The son of a Moscow military doctor who was murdered by his serfs, Dostoyevsky grew up in materially comfortable but psychologically damaging circumstances. After finishing a military-engineering education in 1843, he soon turned to literature. His first published work, *Poor Folk* (1846), was widely hailed in literary circles, but subsequent works in the 1840s, among which were *The Double* (1846), *Mr. Prokharchin* (1846), *The Landlady* (1847), and *Netochka Nezvanova* (1849), were less warmly received.

In 1849, Dostoyevsky was arrested for participation in a mildly subversive group, the Petrashevsky Circle, and sentenced first to prison and then to a harsh exile in Siberia for a total of ten years. These experiences—and especially his last-minute reprieve from an expected execution—led him to embrace more fervently his Orthodox religious values and to reject the West as a model for Russian society. Along with the consumptive wife he had married, he returned to St. Petersburg in 1859 and there entered the major phase of his literary career.

A number of works of indifferent quality—*A Friend of the Family* (1859), *The Uncle's Dream* (1859), *Memoirs from the House of the Dead* (1860–61), and *The Insulted and Injured* (1861)—preceded *Notes From the Underground* (1864), a powerful work considered the philosophical testament of existentialism as well as prologue to Dostoyevsky's great tragic novels. The Underground Man is a cynical denizen of St. Petersburg, alienated from his surroundings and the rest of humankind, who nevertheless poses a powerful challenge to the impersonal forces of rationalism, progress, and social engineering.

In 1866, Dostoyevsky published Crime and Punishment, a novel of redemption through suffering that represents a "testing" of the limits of individual freedom and is a gripping metaphysical detective story. In 1867, he traveled to Germany and Switzerland with his new bride, Anna Grigorievna Snitkina. He remained abroad until 1871 and there completed *The Idiot* (1868), the warmly ironic story of Prince Mishkin, a saintly epileptic, a man who is ineffectual because of his positive goodness. His next novel, *The Possessed* (1871–72), reflects Dostoyevsky's negative reaction to the political changes that had occurred in Russia between the 1840s and 1860s, more specifically to the radicalism that had supplanted the liberalism of the 1840s. He had no sympathy for the radicals' contempt for established authority, religion, the family, and most humanistic values.

In the first part of the 1870s, Dostoyevsky attempted to reconcile himself with the liberal elements in Russia; *The Adolescent, or A Raw Youth* (1875) is the fruit of this attempt. In 1876 he began publication of *The Journal of a Writer*, a monthly miscellany with comments on politics, international news, literary events, some fiction, and matters of general interest. This journalistic endeavor became the work sheet for his last and greatest novel, *The Brothers Karamazov*. In 1877 he discontinued publication of *The Journal of a Writer* in order to work exclusively on *The Brothers Karamazov*, which he completed in 1880.

Dou, Gerard [dow] The Dutch portrait and genre painter Gerard Dou, also known as Gerrit Dow or Douw, b. Apr. 7, 1613, d. February 1675, was one of the young REMBRANDT's first pupils. Dou's style evolved differently from his master's; he founded the Leiden school of *fijnschilders*, "fine painters," developing a meticulous, small-scale art that was popular. Queen Christina of Sweden retained a minister to buy his works, and the Dutch government selected Dou's *Young Mother* (1658; Mauritshuis, The Hague) to present (1660) to Charles II of England on the restoration of the monarchy. Representative of Dou's mature style is *The Night School* (*c*.1665; Rijksmuseum, Amsterdam).

Douai Douai (formerly Douay) is a town in northern France, situated on the Scarpe River about 25 km (15 mi) south of the Belgian border. Its population is 42,576 (1982). Douai is the commercial and transportation center for the surrounding coal mining region. A belt of industrial suburbs produces a variety of industrial products, including steel, chemicals, transportation equipment, and machinery. The well-known Gothic belfry, built in 1380, is 40 m (130 ft) high. In the 4th century, a Roman fortress, Duacum, was probably built there. During the Middle Ages, when it was held by the counts of Flanders, Douai was a prosperous textile market town. It later passed to the dukes of Burgundy (1384) and to the Habsburgs (1477). In 1568 a Roman Catholic college for English priests was established there, and they produced the Douay-Reims Bible (1582, 1609), one of the most important early English translations of the Bible. Seized by Louis XIV of France in 1667, Douai became a permanent part of France in 1713.

Douala [doo-ah'-lah] Douala is the chief port and commercial city of Cameroon in west central Africa. It is located on the Wouri River, about 32 km (20 mi) inland from the Bight of Biafra, and has a population of 1,029,000 (1986 est.). The city is a major focus of the air, rail, road, and sea traffic of West Africa. First visited by Portuguese explorers in 1472, Douala was a center of the African slave trade and became the capital of a German protectorate in 1884. The city was held by the French from 1916 to 1960 and remains French-speaking.

double bass The double bass, also called bass VIOL or contrabass, is the largest and lowest-pitched member of the orchestral stringed instruments. The standard double bass has four strings and a range from E an octave below the bass staff, upwards for nearly three octaves; some instruments may have five strings in order to extend the range downward. Some early double basses had only three strings. The instrument is played with a heavy bow and sounds an octave lower than its written notes. Its body shape differs from the other members of the violin family in having sloping rather than rounded shoulders and usually having a flat rather than a convex back.

The double bass, the lowest-pitched member of the violin family, probably developed from the double-bass viol. The double bass stands 1.8 m (6 ft) tall and has four strings tuned in fifths. It is played standing.

double bond see CHEMICAL BOND

double jeopardy The prohibition against being put in double jeopardy, or tried twice for the same offense, is a protection provided by the 5th Amendment to the CONSTITUTION OF THE UNITED STATES and by most state constitutions. This provision, however, is not absolute. Trials that end in a "hung jury" and some mistrials, as they are not regarded as trials at all, do not prevent a defendant from being tried again. This protection also does not preclude different jurisdictions—both state and federal courts, for example—from trying an individual for the same crime. The constraint against double jeopardy does mean, however, that a jurisdiction may not retry an individual for an offense of which he or she has been acquitted.

double star see BINARY STARS

Doubleday, Abner Abner Doubleday, b. Ballston Spa, N.Y., June 26, 1819, d. Jan. 26, 1893, was an American military officer who is often incorrectly credited as the originator of baseball. According to the popular legend, Doubleday devised (1839) the game of "baseball" while a schoolboy at Green's Select School in Cooperstown, N.Y. Although it has not been proved that Doubleday was ever in Cooperstown during his lifetime, the Cooperstown-Doubleday story was widely popularized. Although Doubleday's importance in baseball lore is probably mythical, Cooperstown remains baseball's adopted "home."

Doughty, Thomas Thomas Doughty, b. Philadelphia, July 19, 1793, d. July 24, 1856, was one of America's earliest landscape painters. A self-taught artist, he was a member of the HUDSON RIVER SCHOOL. Doughty's detailed, representative paintings are characterized by luminosity and strong contrasts of light and shade, as, for example, *In Nature's Wonderland* (1835; Detroit Institute of Arts). His first one-man exhibition, at which he showed eight canvases, was held in 1824 at the Pennsylvania Academy of the Fine Arts in Philadelphia.

Douglas (family) The Douglas family dates back to the 12th century in Scotland. Scottish history is full of the exploits of the Black Douglases, earls of Douglas, and the Red Douglases, earls of Angus. **Sir James Douglas**, b. *c.*1286, called the Black, was at the Battle of Bannockburn, where he helped ROBERT I (Robert the Bruce) defeat the English. After a series of raids into the north of England, Sir James was awarded numerous estates. He went on crusade against the Moors in Spain, where he was killed on Aug. 25, 1330. His nephew, **William**, *c.*1327–84, established the Black Douglas line.

James, 2d earl of Douglas, *c.*1358–88, won the Battle of Chevy Chase (or Otterburn) against the English. Mortally wounded, he instructed his soldiers to raise his standard and to keep his death a secret until victory was achieved.

William, 6th earl of Douglas, *c.*1423–40, was murdered on the orders of ministers of King JAMES II in Edinburgh Castle. The family estates were then divided between James, 7th earl, who was the son of the 3d earl, and Margaret, the 6th earl's sister. The estates were united when Margaret married **William**, *c.*1425–1452, son of the 7th earl and himself 8th earl. However, the 8th earl was stabbed to death by James II at Stirling, and his brother **James, 9th earl of Douglas**, 1426–88, was deprived of his title in 1455.

The Red Douglases became the earls of Angus when **George**, *c.*1380–1403, illegitimate son of William, 1st earl of Douglas, married (1397) Mary, daughter of King Robert III. **Archibald, 6th earl of Angus**, 1489–1557, married (1514) Margaret Tudor, widow of JAMES IV and sister of Henry VIII of England; their daughter was the mother of Lord DARNLEY. The Red Douglas estates ultimately passed to the earls of Home and the titles to the dukes of Hamilton.

Douglas, Donald Wills Donald Wills Douglas, b. Brooklyn, N.Y., Apr. 6, 1892, d. Feb. 1, 1981, was the developer of the DC-3 and other aircraft. He attended the U.S. Naval Academy and Massachusetts Institute of Technology, worked for the Glenn L. Martin Company during World War I, and in 1920 formed the Douglas Aircraft Company. In 1933, Douglas developed a two-engined transport, the DC-1, that carried 12 passengers at a cruising speed of 274 km/h (170 mph). The DC-3, which carried 21 passengers at a speed of 309 km/h (192 mph), soon accounted for most of the U.S. passenger traffic. Douglas aircraft were used by the military during World War II. In 1967, Douglas Aircraft merged with another company to form the McDonnell Douglas Corporation, the producer of the DC-10 passenger transport, the F-15 fighter-bomber, and spacecraft.

Douglas, Sir James Sir James Douglas, b. Aug. 15, 1803, d. Aug. 2, 1877, is known as the father of British Columbia. Born in British Guiana, he went to Canada to enter the service of the NORTH WEST COMPANY in 1819. After that company's absorption by the rival HUDSON'S BAY COMPANY in 1821, Douglas rose to become a member of the Board of Management of the Columbia District. The Hudson's Bay Company later transferred its headquarters to Fort Victoria, Vancouver Island, which became a crown colony in 1849. Douglas became the colony's second governor in 1851. When gold was discovered on the mainland, British Columbia also became a crown colony, and Douglas served as its governor from 1858 to 1864. Determined to prevent an American takeover, he governed the colony with a firm hand. His administration was marked by honesty and punctiliousness.

Douglas, Stephen A. A U.S. senator for 14 years and a presidential contender, Stephen Arnold Douglas was a major figure in pre–Civil War politics. He is best remembered for his debates with Abraham LINCOLN on the

Stephen A. Douglas, Democratic senator from Illinois (1847–61), was at the center of the debate over the extension of slavery into the Western territories. He proposed that the residents of the territories should decide the issue for themselves, a policy called popular sovereignty. Douglas campaigned unsuccessfully for the presidency in 1860.

question of slavery in 1858. Born in Brandon, Vt., on Apr. 23, 1813, Douglas settled in Illinois, where he was admitted to the bar. He rose rapidly in the Democratic party, holding several state and local offices before being elected to the House of Representatives in 1843. From 1847 until his death, on June 3, 1861, he was a U.S. senator.

In the Senate, Douglas chaired the Committee on Territories, an important post because of the growing controversy over the extension of slavery into the territories. Although Douglas was one of the architects of the Compromise of 1850, he reopened the slavery issue in 1854 when he sponsored the Kansas-Nebraska Act, which repealed the Missouri Compromise. In its place, he advocated the doctrine of popular sovereignty, whereby territorial settlers would be allowed to decide on the slavery issue after they achieved statehood. The issue persisted, however, and Kansas was soon in turmoil.

Douglas was bypassed for the Democratic presidential nomination in 1856, largely because of the situation in "bleeding Kansas." In 1857 he broke with President James Buchanan over the latter's support of the proslavery forces in Kansas. This alienated Douglas from Southern Democrats. In 1858, Douglas defeated Lincoln in a hard-fought senatorial campaign. The well-publicized Lincoln-Douglas debates, however, helped bring Lincoln to national attention while further alienating Douglas from Southern Democrats because of his inability to reconcile popular sovereignty with the Dred Scott v. Sandford decision (1857).

Douglas received the presidential nomination of the non-Southern wing of the Democratic party in 1860, but the fragmentation of the Democrats allowed Lincoln to win an easy victory. When the Civil War broke out, Douglas supported Lincoln. Stricken with typhoid while on a speaking tour in support of the Union, Douglas died in Chicago in 1861.

In addition to his prominent political career, Douglas was a wealthy land speculator in and around Chicago. He helped make that city a major railroad terminus.

Douglas, T. C. Thomas Clement Douglas, b. Falkirk, Scotland, Oct. 20, 1904, d. Feb. 24, 1986, led the first socialist government in a Canadian province. A Baptist minister in Saskatchewan in the early 1930s, "Tommy" Douglas then served in the Canadian House of Commons (1935–44) as a member of the socialist Cooperative Commonwealth Federation (CCF). As CCF premier of Saskatchewan (1944–61), Douglas introduced many social and economic reforms, including the groundwork of medicare. He was the founding leader (1961–71) of the New Democratic party, also serving again in Parliament (1962–68, 1969–79).

Douglas, William O. William Orville Douglas, b. Maine, Minn., Oct. 16, 1898, d. Jan. 19, 1980, was a controversial associate justice of the U.S. Supreme Court who distinguished himself as a defender of 1st Amendment rights. Douglas's experience of poverty growing up in Yakima, Wash., influenced his lifelong sympathy for the poor and the disadvantaged. After graduating from Whitman College in Walla Walla (1920) and Columbia University Law School (1925), he taught at Columbia and at Yale University, specializing in business law. He became a close friend and advisor of President Franklin D. Roosevelt, who appointed him to the Supreme Court in 1939. On the Court, Douglas championed the individual's right to privacy and freedom of expression while promoting the federal government's power to regulate the economy. He was a frequent target of conservative critics who disliked his permissive attitudes on such matters as obscenity and civil disobedience, as well as his concern for the protection of accused criminals. Others criticized his three divorces and his marriages to women much younger than himself. Attempts were made to impeach him in 1953, 1966, and 1970. Among his most influential opinions were those in *Federal Power Commission* v. *Hope Natural Gas Company* (1942), which set a precedent in federal rate regulation, and Griswold v. Connecticut (1965), which invalidated a state law against birth control. Douglas retired in 1975. His numerous writings include *Of Men and Mountains* (1950), *A Living Bill of Rights* (1961), *Go East, Young Man* (1974), and *The Court Years* (1980).

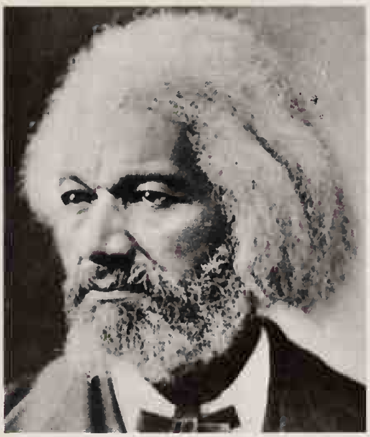
William O. Douglas served as a U. S. Supreme Court justice for more than 36 years—the longest term in the Court's history. Considered a liberal, he was known for his strong application of the Bill of Rights and for his belief in extensive use of the Court's powers.

Douglas fir The Douglas fir, genus *Pseudotsuga*, is the common name for six species of tall evergreen trees; two are found in western North America, and the others in eastern Asia. These members of the pine family have furrowed, dark brown bark; flattened needlelike leaves; and oblong cones with distinctive three-pointed bracts. *P. menziesii*, the more common North American species, ranges from British Columbia to northern Mexico at altitudes from sea level to 3,300 m (11,000 ft). These long-lived conifers are among the world's most important timber trees. Douglas fir is used for reforestation and is also planted in Europe and the northeastern United States as an ornamental in landscaping.

The Douglas fir, native to the Pacific Northwest, is cultivated as an ornamental tree and for its timber.

Douglas-Home, Sir Alec [duhg'-luhs-huem] Sir Alexander Frederick Douglas-Home, b. July 2, 1903, was Conservative prime minister of Britain in 1963–64. Elected to Parliament in 1931, he was defeated in the 1945 general election but returned to the House of Commons in 1950. In 1951 he succeeded to his father's peerage, as the 14th earl of Home, and entered the House of Lords. After the return of the Conservatives to power in 1951, Home served as minister of state for Scotland (1951–55) and secretary of state for commonwealth relations (1955–60). Appointed foreign secretary in 1960, he renounced his peerage to sit in Commons. He succeeded Harold Macmillan as prime minister on Oct. 19, 1963, serving until the Conservative defeat on Oct. 16, 1964. He returned as foreign secretary (1970–74) in Edward Heath's government. In 1974 he was made a life peer as Baron Home of the Hirsel.

Douglass, Frederick Frederick Douglass, born a slave near Easton, Md., in February 1817, d. Feb. 20, 1895, became the most famous of all black ABOLITIONISTS as well as one of the greatest American orators of his day. As a young man he was sent to Baltimore, where he learned ship caulking. Already schooled in the alphabet by his master's wife, he taught himself to write by tracing the letters on the prows of ships. In 1838, with seaman's papers supplied by a free black, he escaped to New Bedford, Mass. Five months later he came into contact with William Lloyd GARRISON's antislavery weekly, the *Liberator*, and in 1841 he was enlisted as an agent by the Massachusetts Anti-Slavery Society, which had been impressed by his oratorical skill.



The American abolitionist Frederick Douglass's incessant struggle for the emancipation and enfranchisement of his people made him one of the most effective and respected black leaders of the 19th century.

Douglass's speeches evolved from reminiscences of slave life to a denunciation of slavery and a call for immediate abolition. As his speeches became more polished, fewer people believed that he actually had been a slave. To dispel such doubts, Douglass published (1845) his *Narrative of the Life of Frederick Douglass* (later titled *Life and Times of Frederick Douglass*), although this meant risking reenslavement. He then settled in Rochester, N.Y., where he founded his newspaper, the *North Star*.

When the Civil War came, Douglass fought for the enlistment of black men in the Union army and assisted in recruiting the 54th and 55th Massachusetts Colored Regiments, which later won distinction in battle. As the war progressed, President Lincoln conferred with Douglass as a representative of his people.

During his last years Douglass served as assistant secretary of the Santo Domingo Commission (1871), marshal (1877–81) and recorder of deeds (1881–86) of the District of Columbia, and U.S. minister to Haiti (1889–91). Douglass remained an active reformer literally until the day he died, when he collapsed after attending a women's suffrage meeting.

Doukhobors [dook'-uh-bohrz] The Doukhobors, or "spirit wrestlers," are a mystical sect that originated in 18th-century Russia. Facing persecution in Russia, most of its members emigrated to Cyprus and Canada about 1898. Appealing to an inner presence of the Holy Spirit, they rejected the hierarchy, sacraments, and other traditional practices of the Orthodox church. Today they also refuse military service and obligatory schooling. Their spiritual leaders, who are called "Christs," or "Messiahs," claim to possess Christ's soul. A 19th-century "Messiah," Pyotr Vasilievich Verigin, was aided by Leo Tolstoi and the English Quakers in arranging the emigration and settlement of the sect in Saskatchewan and British Columbia. The Doukhobors are now divided into several competing groups. The Doukhobors are now called the Union of Spiritual Communities of Christ.

Doumergue, Gaston [doo-mairg'] Gaston Doumergue, b. Apr. 1, 1863, d. June 18, 1937, was president of France from 1924 to 1931 and twice premier (1913–14, 1934). He was first elected to the Chamber of Deputies as a Radical in 1893 and in 1910 won a seat in the Senate. His presidential term (1924–31) was marred by instability. In February 1934, following the antidemocratic riots provoked by the STAVISKY AFFAIR, Doumergue was asked to form a coalition government. His proposals to strengthen executive powers met with strong leftist opposition, however, and his government fell on Nov. 8, 1934.

Doura-Europos see DURA-EUROPUS

Douro River [doh'-roo] The Douro River (Spanish: *Duero*), rising in the Sierra de Urbión of north central Spain, flows south and west to form part of the Portugal-Spain border. It enters the Atlantic Ocean just south of Porto, Portugal. Over a course of 895 km (556 mi) it drains a catchment area of 79,100 km^2 (30,500 mi^2). Dams, especially the Aldeadávila Dam (Spain) and the Bernposta Dam (Portugal), make it an important source of hydroelectric power. Used for irrigation, it is navigable only in part.

dove Dove is the common name for various species of birds in the family Columbidae, order Columbiformes. Other species in the same family are called PIGEONS. There is no biological distinction between the two. Smaller species are often called doves, and larger species, pigeons, but this usage is inconsistent. The domestic pigeon, *Columba livia*, for example, is known also as the rock dove. The reason is historical: *dove* is of Anglo-Saxon origin, while *pigeon* is French.

The rock dove, more commonly known as the domestic pigeon, is a familiar inhabitant of city parks and of suburban and rural areas throughout North America and Europe.

Dove, Arthur Arthur Garfield Dove, b. Canandaigua, N.Y., Aug. 2, 1880, d. Nov. 22, 1946, was one of the first American artists to use abstract imagery in his paintings. At the Salon d'Automne of 1909, Dove exhibited paintings done in an impressionistic style that were reminiscent of Paul CÉZANNE. Returning to the United States in 1909, he began to paint the stylized organic forms characteristic of his later, more abstract works. In 1910 he met Alfred STIEGLITZ, who encouraged and supported him, organizing (1912) Dove's first one-man show at his gallery *291*.

Sometime after 1910, Dove painted six small oil paintings called *Abstraction Numbers 1–6* (private collections), paralleling the work of the European abstractionists. The pastels entitled *The Ten Commandments*, or *Nature Symbolized*, demonstrate the velvety, dense color so typical of Dove's later paintings. Known for his pastels and watercolors, Dove also produced a series of collage works during the 1920s. His style became increasingly abstract.

dovekie see AUK

Dover (Delaware) Dover (1990 pop., 27,630) is the capital of the state of Delaware and the seat of Kent County. It is located in the center of the state on the Saint Jones River and dominates the agricultural region to the south. Food processing is the predominant industry. Nearby Dover Air Force Base, site of one of the world's largest military air-cargo operations, is also a major employer. Dover, first settled in 1683, was made the state capital in 1777.

Dover (England) Dover (Dover district 1987 est. pop., 104,300) is a city on the east coast of Kent in southeastern England. Located on the Strait of Dover, Dover is an important naval base and the leading passenger port in Great Britain. The main railroad and ferry depot for crossing the English Channel is located there, as is a port for the hovercraft trip to Calais. Dover is both a center for light industry and a resort.

Dover was an important Roman port known as Dubris. Besieged in 1216 by the French, it was the major city of the Cinque Ports and the site of the signing of the secret 1670 treaty between Charles II of England and Louis XIV of France. Dover Castle, with its Norman keep and Saxon chapel, is on the famed white chalk cliffs above the harbor.

Dovzhenko, Alexander [dohv-zhen'-koh] Alexander Dovzhenko, b. Sept. 11 (N.S.), 1894, d. Nov. 25, 1956, was an important early Soviet filmmaker. The son of peasants, he worked as a schoolteacher, diplomat, and political cartoonist before turning to filmmaking in 1926.

White chalk cliffs extend along the shores of the English Channel. The channel, separating England from continental Europe, is less than 34 km (21 mi) across between the English port of Dover and the French port of Calais.

The first notable film he directed was the political allegory *Zvenigora* (1928). Thereafter, his work was strictly censored. His principal films include *Arsenal* (1929), dealing with the Civil War in the Ukraine; *Earth* (1930), on the national struggle over collectivization; and the lyrical *Shchors* (1939). During World War II, Dovzhenko produced such distinguished documentaries as *Liberation* (1940) and *Ukraine in Flames* (1945).

Dow, Herbert Henry Herbert Henry Dow, b. Belleville, Ontario, Feb. 26, 1866, d. Oct. 15, 1930, founded (1897) the Dow Chemical Company. While a student at the Case School of Applied Science, Cleveland, Ohio, he wrote his thesis on the chemistry of Ohio brines. His teachers encouraged him to continue his research, and as a result he subsequently discovered a method for extracting bromine from brine with the aid of electricity. He was granted more than 100 patents.

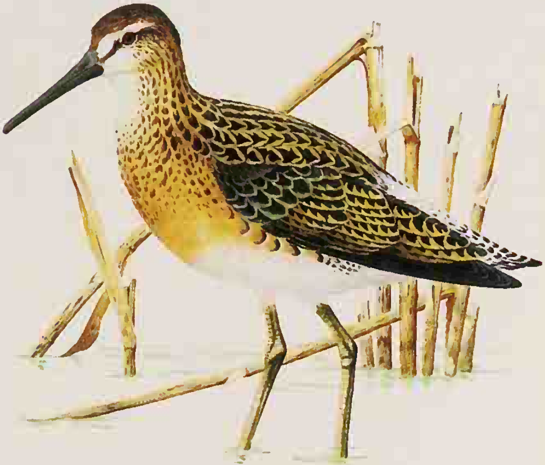
Dow-Jones average The Dow-Jones industrial STOCK average, commonly used as an indicator of changes in the general level of stock prices in the United States, is based on the prices of 30 industrial stocks. The stocks are selected as being representative of industrial stocks in general. Dow Jones & Company, a financial publisher based in New York, also calculates averages for transportation stocks, utility stocks, and bonds. Other well-known indexes include Standard and Poor's Composite 500 Index, the New York Stock Exchange Common Stock Index, and the American Stock Exchange Index. Many indexes are published for groups of stocks such as bank stocks, chemical stocks, oil stocks, and machinery stocks.

See also: STOCK MARKET.

dower see INHERITANCE

Dowie, John Alexander John Alexander Dowie, b. Edinburgh, Scotland, May 25, 1847, d. Mar. 9, 1907, founded (1896) the Christian Catholic Apostolic church in Zion, now called the Christian Catholic church. Ordained (1870) to the Congregational ministry in Australia, he became convinced that he possessed the gift of divine healing through prayer. He went to the United States (1888) and founded Zion City, Ill., in 1901. The church survives as a small sect with a missionary orientation.

dowitcher [dow'-ich-ur] The dowitcher is a medium-sized (30-cm/12-in) shore bird of the genus *Limnodromus*, family Scolopacidae, with a stocky body and a long, thin, straight bill. Two species occur in North America: the eastern short-billed dowitcher, *L. griseus*, which is actually long-billed, and the western long-billed dowitcher, *L. scolopaceus*.



The short-billed dowitcher, a sandpiper of North American salt marshes and mud flats, is shown wearing its summer plumage. In winter it has gray back feathers with white tail feathers.

Dowland, John John Dowland, b. Ireland, December 1562, d. Jan. 21, 1626, was an English composer and lutenist and a pioneer in the development of the English art song. Dowland was in the service of the English ambassador in Paris (1579–84), and later became lutenist to the king of Denmark (1598–1606). In 1597 he published his *First Booke of Songes or Ayres*, which was later followed by three similar collections. These four books are generally considered the most important contribution by an English composer to the literature of the solo song with lute accompaniment. Equal in quality are Dowland's accompanied part songs and instrumental music. From 1612 to 1626, Dowland was lutenist to James I and Charles I. His reputation as a composer and as a lute performer was international.

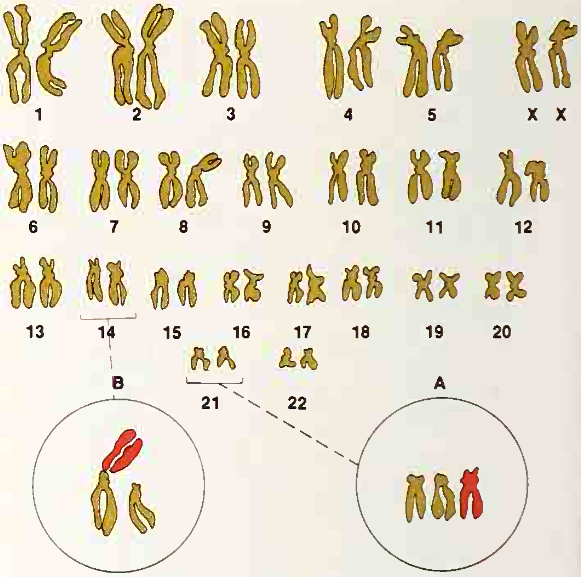
Down Down (Irish: An Dún) is a former county in Northern Ireland. In 1973 it was divided into the districts of Down, Ards, Banbridge, and North Down, and parts of Castlereagh, Newry and Mourne, Craigavon, and Lisburn. The present district of Down has a population of 52,869 (1981) and covers an area of 646 sq km (249 sq mi). Oats, barley, wheat, and hay are grown, and sheep and pigs are raised. Downpatrick, the administrative seat, is the reputed burial place of St. Patrick.

Downing, Andrew Jackson Andrew Jackson Downing, b. Newburgh, N.Y., Oct. 30, 1815, d. July 28, 1852, was America's first major landscape designer. He was a prolific author of horticultural and gardening books, and his *Treatise on the Theory and Practice of Landscape Gardening* (1841) and *Cottage Residences* (1842) greatly influenced American tastes in residential landscaping throughout the 19th century. As editor (1846–52) of *The Horticulturist* he initiated the campaign to create Central Park in New York City.

Down's syndrome Down's syndrome, or Down syndrome, is a human disorder caused by chromosome abnormalities that develop during germ-cell formation. If the affected ovum or sperm takes part in fertilization, the fetus will exhibit the syndrome (see GENETIC DISEASES). Characteristics include moderate to severe mental deficiency, slow physical development, stocky build, short hands, and flattened facial features. An English doctor, Langdon Down, first described Down's syndrome in 1866 and called it mongolism. His name was later given to the disorder.

In 1959 a French biologist, Jerome Lejeune, established that production of a germ cell with an extra chromosome 21 (see GENETIC CODE)—an event more likely to occur the older the mother is—is the most common cause of Down's syndrome. About 4% of the cases instead result from an inherited tendency of one chromosome (usually a third number 21) to break off and join another (usually number 14). Depending on the genes involved, the child may exhibit the full syndrome or show few or no effects. Chromosome 21 is the smallest human chromosome, with no more than 1,500 genes, but the genes are of great interest for being involved in conditions ranging from cancer to ALZHEIMER'S DISEASE to vision problems.

About one out of every 800 babies born in the United States has this syndrome. More than 40% of them have congenital heart defects, and many have poorly developed digestive tracts and immune systems; they are also more prone to leukemia than are normal children. Prior to World War II, children with the syndrome rarely grew to adult age, but with improved medical practices and home care their life expectancy is now about 50 years. After the age of 35, however, almost all of them develop brain lesions and neuritic plaques like those in persons with Alzheimer's disease; current research is exploring this shared pathology. Down's is detectable in a fetus by amniocentesis, but tests for parental predisposition do not yet exist.



Down's syndrome is caused by certain chromosome abnormalities. The normal human chromosome number is 46; each somatic cell has 22 pairs of autosomes and 1 pair of sex chromosomes (XX in a woman, as shown). If the sex cell receives an extra chromosome 21 when formed, the child will have three chromosomes 21 in each cell (A)*—the most common cause of the syndrome. The syndrome may also be caused by translocation, in which part of one chromosome—usually a third number 21 (orange)—breaks off and attaches to a larger one, usually chromosome 14* (B).

dowry Especially in former times, the property that a bride brought with her to marriage was termed her *dowry*. A substantial dowry enhanced her attractiveness as a spouse, strengthened interfamily ties, and served as a financial base for the newlyweds. In English common law, a woman's dowry and other possessions traditionally became the property of the man she married, although she did have some rights to it in equity. In countries governed by Roman or civil law, the husband managed his wife's dowry but did not own it outright. With the passage of laws granting women equal property rights in the 19th century, the importance of dowries declined in the West. In other parts of the world, however, they continue to play a major role in marriage settlements. In traditional African societies the payment of a dowry is accompanied by the payment of a bride-price by the family of the groom.

dowsing Dowsing is the practice of using a forked stick as the operative instrument in discovering underground water, buried metal, or metal ores. Although not credited by science, this ancient practice continues to have many adherents. Besides using a Y-shaped stick, a dowser may also employ wood or iron rods, pendulums, or simply his or her own hands.

Dowson, Ernest Ernest Christopher Dowson, b. Aug. 2, 1867, d. Feb. 23, 1900, was an English poet whose work is characteristic of late-19th-century English aestheticism. Haunted by the death (1894) of his father and his mother's suicide six months later, Dowson wrote poetry marked by the decadent themes of sensuality and bitterness. He lived intermittently in France, where he was influenced by French symbolism. His most famous poem, "Non Sum Qualis Eram Bonae sub Regno Cynarae" (1891), contains the often-quoted line: "I have been faithful to thee, Cynara, in my fashion." His health was destroyed by alcoholism, and he died of tuberculosis at age 32.

Dowth Dowth, a hamlet in County Meath, Ireland, is the site of an important passage grave of the 3d millennium BC. With KNOWTH and New Grange, it forms part of an extensive Late Neolithic cemetery in the Boyne River valley, north of Dublin. Measuring 84 m (278 ft) in diameter, the mound at Dowth covers two funerary chambers designed for communal burial, one with a short entrance passage and a single side chamber, the other with a slightly longer passage and a complex arrangement of side recesses leading from its cruciform end chamber. A number of the megalithic orthostats, or large stone slabs, lining the tomb are ornamented with spiral and lozenge designs.

doxology In Christian worship, a doxology is a prayer or hymn offering praise to God, usually in the trinitarian form of Father, Son, and Holy Spirit. The name *doxology* is taken from a Greek word meaning "to give glory." Examples in the Western liturgy are the Greater Doxology (*Gloria in excelsis*) and the Lesser Doxology (*Gloria patri*). An English variant is Thomas Ken's "Praise God from whom all blessings flow."

Sir Arthur Conan Doyle, a British novelist, introduced the world's most famous fictional detective, Sherlock Holmes, in A Study in Scarlet *(1887). Doyle later became deeply involved in the study of spiritualism.*

Doyle, Sir Arthur Conan Arthur Conan Doyle, b. May 22, 1859, d. July 7, 1930, was an English novelist who is widely known as the creator of the detective Sherlock Holmes. Doyle was also a medical doctor. His first story featuring Holmes, *A Study in Scarlet*, appeared in *Beeton's Christmas Annual* in 1887. After 1890 he pursued writing full time, completing such further Holmes adventures as *The Memoirs of Sherlock Holmes* (1894), the popular *The Hound of the Baskervilles* (1902), and his last book featuring the detective, *The Casebook of Sherlock Holmes* (1927). Doyle wrote 4 novels and 56 stories involving Holmes. Blessed with an acute sense of deductive reasoning, Holmes, with his genial but less quick-witted companion, Dr. Watson, devises ingenious solutions to complex cases, some involving his archenemy Professor Moriarty. When Doyle tired of the detective in 1893 and attempted to kill him off, public outcry necessitated *The Return of Sherlock Holmes* (1904).

Ironically, Doyle did not want to be remembered for his detective stories but for what he viewed as his more notable work, the historical novels *Sir Nigel* (1906), *Micah Clarke* (1889), and *The White Company* (1890). Doyle also wrote other tales of mystery and adventure, including the science-fiction novels featuring Professor Challenger: *The Lost World* (1911) and *The Poison Belt* (1912). Knighted in 1902, Doyle wrote two pamphlets condoning England's role in the Boer War. After his son died in World War I, Doyle found comfort in spiritualism and later published *History of Spiritualism* (2 vols., 1926–27). In 1924 his autobiographical *Memories and Adventures* appeared.

D'Oyly Carte, Richard [doy'-lee cahrt] Richard D'Oyly Carte, b. May 3, 1844, d. Apr. 3, 1901, was an English theatrical impresario who introduced the comic operas of GILBERT AND SULLIVAN to the English stage. Originally a composer, D'Oyly Carte became a theatrical manager, bringing such French composers as Offenbach to English audiences for the first time. In 1875 he commissioned Gilbert and Sullivan to write the one-act *Trial by Jury*. The production proved so successful that D'Oyly Carte organized an opera company devoted exclusively to mounting their future work, and in 1885 he built the Savoy—the first theater to use electric light—to house their productions. His Royal English Opera House (built 1887) was intended as a showcase for serious opera—Sullivan wrote *Ivanhoe* for it in 1891—but it failed to attract the large and perennial audiences of the Savoy, which soon became something of an English institution.

Under the direction of the D'Oyly Carte family, the

D'Oyly Carte Opera Company continued for over a century to maintain almost unchanged the Gilbert and Sullivan operetta tradition created by the first D'Oyly Carte. In 1982 the company was disbanded because of rising costs.

Drabble, Margaret Margaret Drabble, b. May 6, 1939, is an English novelist whose subject is the intellectual and emotional changes experienced by her protagonists, mostly female, as they traverse the littered landscape of the English welfare state. After working briefly as an actress, she began publishing fiction in 1963. Her novels include *The Millstone* (1965; film, 1969), *The Realms of Gold* (1975), *The Ice Age* (1977), *The Middle Ground* (1980), and *A Natural Curiosity* (1989). She has also written a well-received biography of Arnold Bennett (1974) and a work of literary criticism, *The Genius of Thomas Hardy* (1976). Her scholarly, though idiosyncratic, editorship of the 5th edition of the *Oxford Companion to English Literature* (1985) has been widely praised.

Draco [dray'-koh] Draco was an Athenian legislator of the 7th century BC who, according to Aristotle, created a constitution and the first written legal code. Draco's code, which replaced blood feuds with a state legal system, made so many crimes punishable by death that the adjective *Draconian* is now frequently applied to any repressive legislation. The code was later revised by the legislator SOLON. The constitution that Aristotle ascribes to Draco was almost certainly not by him.

Dracula *Dracula* (1897), a novel by Bram STOKER, chronicles the ascent and destruction of Count Dracula, a vampire who feeds on human blood. Set in London and Transylvania, the story is told in diary form by a young Englishman who gradually unravels the secret of Dracula's attacks on young women, who themselves become vampires. A Dutch metaphysician and scientist, Van Helsing, is summoned to deal with the menace and ultimately kills the vampire. The popular tale has been the subject of many films and dramatizations. In the title role, the actor Bela Lugosi won lasting fame.

See also: VLAD THE IMPALER, PRINCE OF WALACHIA.

Werner Herzog's Nosferatu *(1979) retells the Dracula story, first filmed by F. W. Murnau in 1922. The many other versions include Tod Browning's classic* Dracula *(1931), with Bela Lugosi as the evil count.*

draft (banking) A draft is an instrument of credit drawn upon a bank. It is initiated by the person who is to receive the money. The drawer of the draft, which is also known as a bill of exchange, sends the document requiring payment to the drawee, who accepts it by writing his name across the face of the paper. Several types of drafts are in use. A bank draft is a check drawn by one bank against funds deposited to its account in another bank. If the draft is payable on demand, it is called a sight draft. If it is to be paid at some future date, it is called a time draft.

draft (military) see CONSCRIPTION

draft horse see HORSE

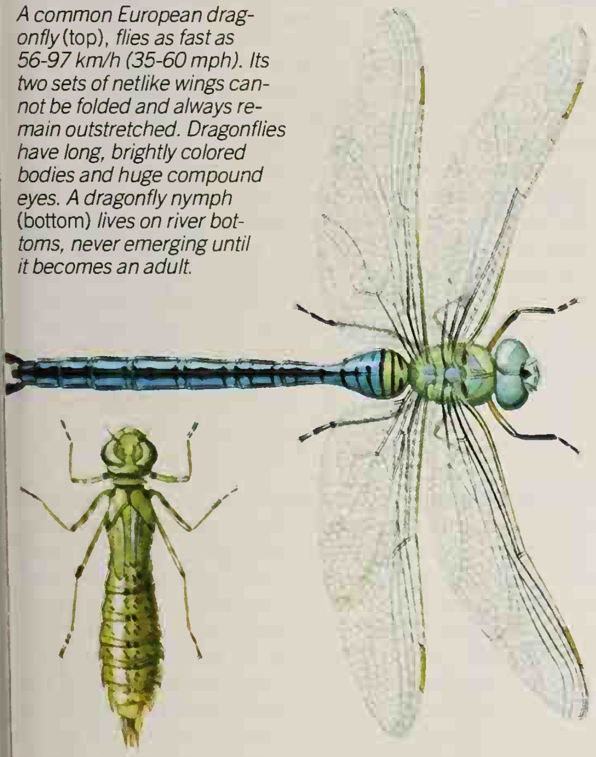
Draft Riots The Draft Riots, a protest against allegedly unjust Union conscription during the Civil War, occurred in New York City on July 13–16, 1863. They took place against a background of dwindling response to President Abraham Lincoln's pleas for Union volunteers in the war and his subsequent order in 1862 that governors draft men into state militias. On Mar. 3, 1863, the Union Enrollment Act was passed, decreeing that all able-bodied males aged 20 to 45 were liable for the draft unless they provided an acceptable substitute or paid $300. This law provoked many disturbances, but the New York City riots were the bloodiest. Workers, largely of Irish descent, battled police and militiamen; there were about 1,000 casualties. Order was restored and the draft resumed by August.

drag racing see AUTOMOBILE RACING

Drago, Luis Mariá [drah'-goh] Luis Mariá Drago, b. May 6, 1859, d. June 9, 1921, was an Argentine diplomat who formulated a supplement to the MONROE DOCTRINE known as the Drago Doctrine. In 1902, Great Britain, Germany, and Italy imposed a joint naval blockade on Venezuela in order to coerce that country into paying its debts. The incident, known as the Venezuela Claims, outraged the other Latin American countries, particularly after the United States declined to invoke the Monroe Doctrine. Drago, who was foreign minister under Argentine president Julio A. ROCA, protested to Washington, enunciating the principle that no public debts should be collected from an American state by coercion. The Drago Doctrine was discussed at the 1906 Pan-American Congress and at the 1907 Hague Conference. The latter chose to adopt a more moderate plan offered by the United States.

dragon An imaginary creature common to many mythologies, the dragon has a reptilian body covered with scales. Many dragons have wings or the head and forelegs of a lion or bird of prey. They usually breathe fire and are associated with water. Most dragons are symbols of evil, but in China some are beneficent, and the dragon was the symbol of the emperor. Dragons are commonly associated with the gods, and in Christian symbolism they are seen as creatures of the devil. They often require human sacrifice, and Perseus, Siegfried, and Saint George are among the legendary heroes who slew dragons.

dragonfly Dragonflies are large predatory insects, with wingspans up to 14 cm (5.5 in), that fly swiftly about, snatching smaller insects from the air by means of their basketlike arrangement of legs. Immature dragonflies, called nymphs, are stout, aquatic predators of insects, tadpoles, and small fish. They emerge, either at night or in early morning, onto vegetation, where they molt to the winged adult form. While mating, both sexes fly in tandem. Dragonflies fly at speeds up to 50 km/h (30 mph), sometimes far from fresh water. Fossil dragonflies of 250 million years ago had wingspans up to 80 cm (31.5 in) and were the largest insects known.



A common European dragonfly (top), *flies as fast as 56-97 km/h (35-60 mph). Its two sets of netlike wings cannot be folded and always remain outstretched. Dragonflies have long, brightly colored bodies and huge compound eyes. A dragonfly nymph* (bottom) *lives on river bottoms, never emerging until it becomes an adult.*

drainage basin see RIVER AND STREAM

drainage systems Ditches, underground pipes, and other devices and techniques used to remove excess water from land constitute drainage systems. Such systems are built to reclaim land for farming, as adjuncts in IRRIGATION projects, in mining, in road and building construction, and for the control of insects that carry diseases.

Wetlands—places where the soil is almost constantly saturated with water—are created either by surface water collecting faster than it can be absorbed into the ground or by a water table that is almost as high as the land surface (see SWAMP, MARSH, AND BOG). The construction of systems to drain wetlands is an ancient agricultural technique, practiced on a huge scale by the Aztecs in pre-Columbian times. The Dutch built up much of their country from saltwater and freshwater marshes, beginning about AD 1000 and continuing to this day (see LAND RECLAMATION).

Drainage of the Italian Pontine Marshes, begun by the ancient Romans, was completed under Benito Mussolini in the 20th century. In recent years, drainage of wetlands has been practiced on a large scale in the United States.

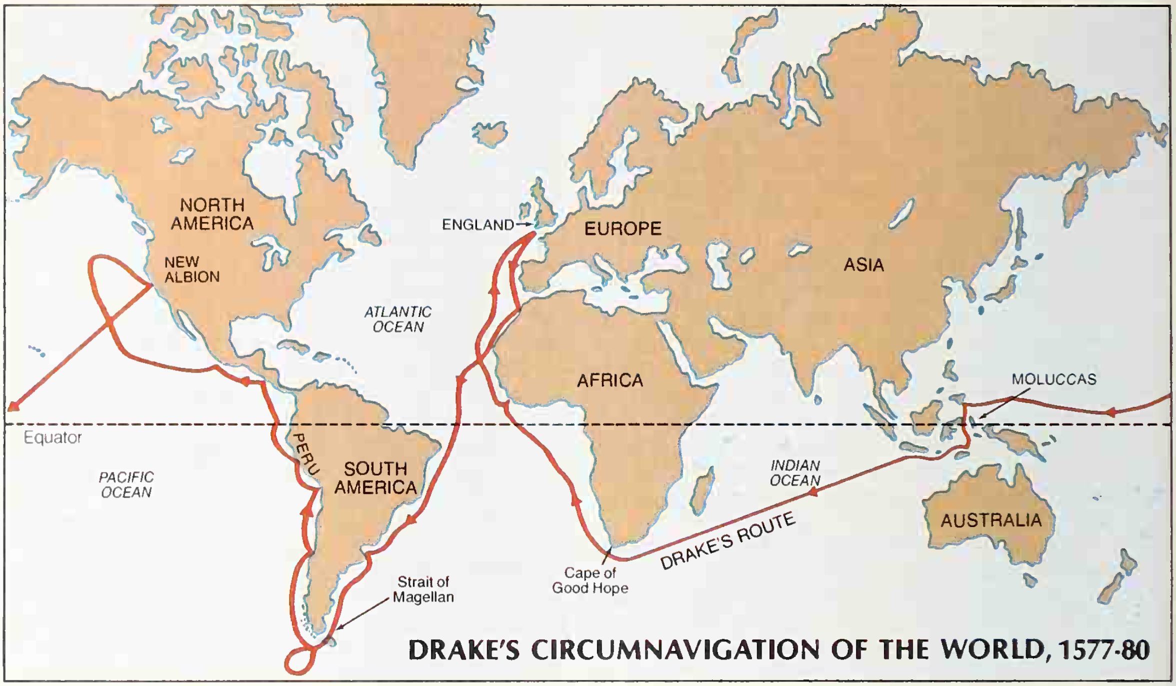
Drainage Techniques. Most large-scale drainage systems consist of surface drains—basically, lined ditches, both covered and uncovered, and small-diameter tile pipe, laid below the soil surface to remove water from the surface level. Both surface and below-ground drains are designed to move water away from the drained area via gravity. Where the land is flat, it is graded to create a slight slope. In irrigated fields with clay or other water-retaining types of soil, water salts may build up in the ground and can be leached out only with the application of more water.

Environmental Considerations. Fewer than 40 million ha (100 million acres) of wetlands remain in the United States today. Increasing knowledge of the vital ecological role they play has slowed U.S. wetlands conversion. In 1979 the U.S. Department of Agriculture began the Water Bank program, which pays farmers to preserve wetlands for wildlife.

Drake, Edwin L. see PETROLEUM INDUSTRY

Drake, Sir Francis Sir Francis Drake, b. *c.*1541, d. Jan. 28, 1596, the most famous English seaman of the Elizabethan Age, is best known for his exploits against the Spanish and his circumnavigation of the world. Born in Devonshire to a poor, staunchly Protestant farming family, Drake went to sea as a youth. In 1567 he sailed under John Hawkins on an expedition that was attacked by the Spanish at San Juan de Ulúa (Vera Cruz, Mexico); only the ships commanded by Hawkins and Drake escaped. Drake scouted the Panama region in 1570 and returned there the next year, when he bombarded several coastal cities and captured much gold and silver.

The deterioration of relations with Spain led Queen Elizabeth I to back an expedition to sail around the world, a feat that had been accomplished only once before, by Ferdinand Magellan. Drake was placed in charge of five



DRAKE'S CIRCUMNAVIGATION OF THE WORLD, 1577-80

small ships and about 160 men and left Plymouth in December 1577. Off the Patagonian coast he had to put down a mutiny and abandoned two small storeships. It took 16 days to pass through the Strait of Magellan; one ship gave up and returned to England and another disappeared during a storm. Thus, by the time he reached the Pacific, Drake was left with only one ship, the *Golden Hind*. He traveled up the coasts of Chile and Peru and sailed far to the north; he touched land in the San Francisco area and claimed the region for England, naming it New Albion. Drake then set off across the Pacific and traded in the Spice Islands (Moluccas). He returned to England via the Indian Ocean and the Cape of Good Hope, reaching Plymouth on Sept. 20, 1580, laden with treasure and spices. For his accomplishments, he was knighted by Queen Elizabeth I.

Sir Francis Drake, the first Englishman to circumnavigate (1577–80) the globe, became a hero in his country for the havoc he wreaked on Spanish shipping. In 1587, Drake destroyed much of the Spanish fleet in Cádiz. The following year he played a prominent role in the defeat of the Spanish Armada.

Drake served as mayor of Plymouth for some years. In 1585, however, he was given command of a large fleet that sacked Vigo, in Spain, then crossed the Atlantic to capture and plunder Cartagena and Santo Domingo and to destroy St. Augustine, in Florida. In 1587 he led a raid on Cádiz, which delayed the attack of the Spanish Armada for a year. Drake played a major role in the successful English defense against the armada in 1588 and was acclaimed as England's hero. A final voyage to the West Indies, begun in 1595, was totally unsuccessful; Drake died off the coast of Panama.

Drake Passage The Drake Passage is the strait between the tip of South America, or Cape Horn, and the South Shetland Islands. It is 1,800 km (500 mi) wide, forming a passage between the Pacific Ocean on the west and the Scotia Sea of the South Atlantic Ocean on the east. Passing through the Straits of Magellan in 1578, Sir Francis Drake was blown far to the south on the Pacific side. He sighted Cape Horn and the open water of the passage, which he thought to be a route to the Indies.

Drakensberg The Drakensberg, literally "Dragon Mountain," is South Africa's major mountain system. It extends over 1,125 km (700 mi) from the Cape Province to the Olifants River in eastern Transvaal. Structurally the mountains have a sandstone base capped by massive thicknesses of basaltic lava. The highest peak is Thabana Ntlenyana (3,482 m/11,425 ft). The escarpment that faces east is a major barrier to road and rail transport. Major assets include spectacular mountain scenery such as Royal Natal National Park near Mont-aux-Sources and Giant's Castle, lush pastures, a high hydroelectric power potential, and pockets of gold and coal. The principal watershed of South Africa, the mountains contain the source of the Orange River.

drama Drama, derived from the Greek verb *dran*, meaning "to act" or "to do," refers to actions or deeds as they are performed in a theatrical setting for the benefit of a body of spectators. More limited than the related concept of theater, which also comprehends such forms as OPERA and DANCE, the term *drama* refers essentially to dramatic literature—the texts composed by playwrights to be spoken in a theater. Only Western drama will be considered in this article; other dramatic traditions are discussed in the article THEATER, HISTORY OF THE and under various national literatures.

Ancient Drama

The origins of Western drama can be traced to the celebratory music of 6th-century BC Attica, centered on Athens. There, it appears that the poet THESPIS developed a new musical form in which he impersonated a single character and engaged a chorus of singer-dancers in dialogue. As the first composer and soloist in this new form, which came to be known as TRAGEDY, Thespis can be considered both the first dramatist and the first actor. He soon had imitators, and in 534 BC a contest in tragedy was instituted at an Athenian festival held in honor of DIONYSUS, the god of wine, fertility, and revelry. This soon became an annual event in Athens and eventually at festivals throughout the Hellenic world.

Of the hundreds of works produced by Greek tragic playwrights, only 32 plays by the three major innovators in this new art form survive. AESCHYLUS created the possibility of developing conflict between characters by introducing a second actor into the format. His seven surviving plays, three of which constitute the only extant trilogy, the ORESTEIA (458 BC), are richly ambiguous inquiries into the paradoxical relationship between humans and the cosmos, in which people are made answerable for their acts, yet recognize that these acts are determined by the gods.

SOPHOCLES raised the number of actors to three (an innovation soon adopted by Aeschylus) and concerned himself more with the conflicts among mortals, although in his plays the hands of the gods are never far from the scene. Following the lead of ARISTOTLE, who with the *Poetics* (*c.*335–322 BC) became the first analyst of the drama, scholars have frequently regarded the plays of Sophocles, among them *Antigone* (441 BC), *Oedipus the King* (*c.*429 BC), *Electra* (*c.* 418–412 BC), and *Oedipus at Colonus* (401 BC), as normative for Greek tragedy; the form, in fact, was undergoing continuous development.

This mosaic, from the 2d century BC, depicts actors preparing for a performance. Western drama originated in the rituals of the Dionysian festivals of ancient Greece. (Museo Nazionale, Naples.)

Some of the 18 extant plays of EURIPIDES—*Medea* (431 BC) and *Hippolytus* (428 BC), for example—resemble in form the tragedies of Sophocles, but in other plays, such as *Iphigenia in Tauris* (*c.*414 BC) and *Helen* (412 BC), he subjected the old values to a subversive sort of skepticism; the myths were domesticated, gods were mocked, and men and women behaved in irrational ways.

Each playwright in the tragic competitions performed four plays: three tragedies followed by a Dionysian satyr play, in which the mythological heroes were confronted by a chorus of drunken half-beasts wearing loincloths and oversized leather phalluses. Euripides' *Cyclops* (*c.*423 BC) is the only complete surviving example.

The only extant examples of so-called Old Comedy, the COMEDY of the prolific 5th century BC, came from ARISTOPHANES. As exemplified by *The Birds* (414 BC), *Lysistrata* (411 BC), *The Frogs* (405 BC), and others, Old Comedy is unlike any modern form, with the possible exception of vaudeville. An absurd premise, milked for all the laughs it could provide through savage topical references and unabashed scatological and sexual humor, was combined with song, dance, serious political exhortation, and sublimely lyrical religious poetry.

With the defeat of Athens by Sparta in 404 BC, Old Comedy disappeared; the new authorities would not permit its pointed satire and licentiousness. The leading practitioner of New Comedy, which developed in its stead, was MENANDER, who set the norms for the subsequent development of comedy: vivid, realistic characters interacting in a complicated but structured plot. The importance of the chorus, and indeed of music, dwindled; the phallus disappeared from the stage, as money, marriage, and family replaced sex.

Roman drama consciously imitated Greek forms. The origins of both Roman tragedy and comedy can be traced to LIVIUS ANDRONICUS, who may have been a Greek slave imported to enliven the Roman civic-religious festivals (*ludi*) in 240 BC. The religious motivation for the drama, however, had long since diminished even in Greece, and Roman drama entered further into the realm of commercial entertainment.

The foremost writer of Roman comedy, PLAUTUS wrote up to 130 plays (21 of which survive), virtually all adapted from or based on Greek New Comedies, and each one fashioned with an eye to pleasing the crowds. Plautus also drew upon the mime tradition, which had flourished for centuries among Greek settlers in the Italian peninsula, in his recurrent use of lively stock characters (see MIME AND PANTOMIME). TERENCE, a black Carthaginian slave educated and freed in Rome, proved less suited to the marketplace; the appeal of his more erudite plays lay instead with the literary set.

Roman tragedy, which very early veered toward bombast, spectacle, and violence to please the masses, was an art that began to rot before it flowered. Although these elements are by no means absent from the plays of SENECA, they were relatively muted, replaced for the most part by philosophical and rhetorical concerns. As a result, Seneca appealed only to the most cultured classes; there is no record of any public performance of his plays.

As the writing and performing of tragedies and comedies waned, various mimic forms superseded them in popularity; Atellan FARCE, originated by the Oscan tribe of Greeks in southern Italy, depended on stock characters for its raucous fun; pantomime relied on the resourcefulness of a mute solo dancer to tell an entire story; anti-Christian mime took special delight in ridiculing the sacraments of the new sect. As Christianity took root in Rome, opposition to the theater grew. The church never succeeded, however, in killing off the Roman theater; this was accomplished, in the 6th century, by invading barbarians.

Medieval Drama

MEDIEVAL DRAMA, when it emerged hundreds of years later, was a new creation rather than a rebirth, the formal drama of ancient times having had virtually no influence on it. The impetus for this creation came, ironically, from a quarter that had traditionally opposed any form of theater: the Christian church. In the Easter service, and later in the Christmas service, bits of chanted dialogue, called tropes, were interpolated into the liturgy. Priests, impersonating biblical figures, acted out minuscule scenes from the holiday stories. Eventually, these playlets grew more elaborate and abandoned the inside of the church for the church steps and the adjacent marketplace. Secular elements crept in as the artisan guilds took responsibility for these performances; although the glorification of God and the redemption of humanity remained prime concerns, the celebration of local industry was not neglected.

The Age of Humanism in Italy and Spain

The vigor of the medieval theater, in decline throughout most of Europe by the 16th century, was succeeded by a new secular drama fashioned by the Italian humanists. In their academies and ducal courts, the Italians began by reviving Plautus and Seneca in Latin but soon progressed to Italian plays written in imitation of the ancient style. Lodovico ARIOSTO, Pietro ARETINO, and Nicolò MACHIAVELLI with *Mandragola* (*c.*1514) were among the most notable poets to try their hands at this *commedia erudita*, or "learned comedy." Even more influential internationally was Torquato Tasso's pastoral drama *Aminta* (1573).

Meanwhile, professional players outside the courts and academies filched the plots and poetry of the learned drama but also developed, after 1550, a new form of their own: the COMMEDIA DELL'ARTE. Dealing largely in improvisation with a cast of stock characters, it remained robust for two centuries, while the learned drama, flirting with music, elaborate scene design, and spectacle in the popular *intermezzi* of the late 16th century, was eventually overwhelmed by the baroque opera. When the *commedia dell'arte* flagged in the mid-18th century, it was given new life by Carlo GOLDONI and Carlo GOZZI, who, in differing degrees, converted this improvisational form into a literary dramatic form.

No country fostered the religious drama of the Middle Ages longer than Catholic Spain. Even during the Golden Age of Spanish drama (1580–1680), the major playwrights earned their livings by creating both religious plays (*autos sacramentales* and lives of the saints) and secular dramas, the latter dealing with historical events, with upper-class intrigue, or even with the common people. To Lope de VEGA, the most prolific and popular playwright of the day, about 1,800 plays are attributed, of which nearly 500 survive. His successor, CALDERÓN, also wrote for the public theaters, but he achieved further success with his allegorical, mythological, and often spectacular court dramas, as well as with the form of the *auto*, which he raised to a new level of sophistication. His *Life Is a Dream* (*c.*1636) remains one of the most profound ruminations on the mysteries of human existence.

England: Elizabethan and Jacobean Drama

From the confluence of the religious and humanist traditions, along with a native farce tradition, there emerged in mid-16th-century England one of the great eras in world drama: the Elizabethan-Jacobean age (see ELIZABETHAN AGE).

Within the religious tradition, the morality play exercised the greatest influence over later English drama. In plays such as *Everyman* (*c.*1500), abstract qualities came to life and struggled for dominion over the soul of man. The native farce tradition yielded John HEYWOOD'S *Johan Johan* (1533), a prototypical triangle of adultery involving a henpecked husband, shrewish wife, and lecherous priest.

This woodcut is a facsimile of the title page of Thomas Kyd's The Spanish Tragedy *(c.1588). With this work, a combination of Senecan drama and the medieval morality play, Kyd introduced the revenge tragedy to Elizabethan drama.*

The humanist tradition, flourishing in grammar schools, universities, and law schools, at first produced comic plays in the ancient Roman tradition. One of the first to depend largely on native English elements was Nicholas Udall's *Ralph Roister Doister* (*c.*1533). It was followed by the anonymous *Gammer Gurton's Needle* (*c.*1560), in which much farcical hubbub surrounds the loss of precisely one needle. *Gorboduc* (1561) was the first English tragic drama in blank verse.

A group of educated writers, known as the University Wits, in applying their learning to the professional theater infused the rough-and-tumble Tudor drama with elements of classical style. The pastoral plays of John Lyly proved that English could be as balanced, elegant, precise, and supple as Latin. Robert Greene imported the romantic comedy from Italy while Thomas Kyd, in *The Spanish Tragedy* (*c.*1588), brought Senecan blood and thunder to the public stage. The greatest poet among the University Wits was Christopher Marlowe, who demonstrated the efficacy of blank verse (unrhymed iambic pentameter) for dramatic expression in English. In *Tamburlaine* (*c.*1586), *Doctor Faustus* (*c.*1588), *The Jew of Malta* (*c.*1589), and *Edward II* (*c.*1592), he created a succession of mighty heroes (or anti-heroes) who held the stage through their insatiable wills and insistent poetry.

Building on all these innovations, shuttling between and blending a variety of forms, creating works of unprecedented subtlety and durability, William Shakespeare—poet, dramatist, actor, and theater co-manager—achieved a primacy among his peers that eventually became a primacy among dramatists of all lands and times. His innovations in tragedy, comedy, romance, and history plays have never been surpassed for daring and accomplishment.

Second only to Shakespeare in Elizabethan comedy, and the most learned dramatist of his day, Ben Jonson proudly sported his familiarity with classical comedy and satire in scathingly moralistic theatrical attacks on the avarice and folly of his countrymen. His *Volpone* (1606), *The Alchemist* (1610), and *Bartholomew Fair* (1614) are among the most frequently revived 17th-century plays. Jonson was also the chief writer of Jacobean court masques.

A remarkable vigor and originality characterized even the lesser dramatists of the day. Thomas Dekker's *The Shoemaker's Holiday* (1600) is a pleasant comedy of the artisan class. John Marston's *The Malcontent* (1604) seethes with the lasciviousness and intrigue typical of the Jacobean era (1603–25). Following Marston's lead came such bold expositions of lust, corruption, treachery, and murder as Cyril Tourneur's *The Revenger's Tragedy* (*c.*1606), John Webster's *The White Devil* (*c.*1610) and *The Duchess of Malfi* (*c.*1613), and Thomas Middleton and William Rowley's *The Changeling* (*c.*1622). The most popular playwrights after the death of Shakespeare were the sometime collaborators Francis Beaumont and John Fletcher (see Beaumont, Francis, and Fletcher, John), who specialized in the more sedate form of romantic tragicomedy. In the Caroline era (1625–42), however, the most important play was John Ford's *'Tis Pity She's a Whore* (*c.*1630), in which the only sympathetic characters are a brother and sister involved in an incestuous affair.

French Neoclassicism

Following the decline of religious drama in the mid-16th century, the French theater had been slow to develop. At the turn of the century, however, France's first professional playwright, Alexandre Hardy, paved the way for neoclassicism in the public theaters, with tragicomedies and pastorals loosely based on classical models.

It was Pierre Corneille's enormously popular tragedy *Le Cid* (1636) and the controversy it aroused that set the standards for the rest of the century's dramatic development. Although today it appears thoroughly classical—a lofty drama of a national hero, his noble lover, and their struggle with conflicting claims of honor—to the newly formed Académie Française it violated certain Aristotelian precepts. Despite this adverse judgment, Corneille went on to create a string of tragedies—among them *Horace* (1640), *Cinna* (1641), and *Polyeucte* (1642)—that are still mainstays of the French repertoire.

Jean Racine experienced his first success with the tragedy *Andromaque* in 1667. Three years later his *Bérénice* proved more popular than Corneille's dramatization of the same story. Whether his settings were Greek, as with *Phèdre* (1677), Roman, as in *Britannicus* (1669), or Oriental, as in *Bajazet* (1672), his major tragedies all delve beneath the classical surface to probe the irrational, fierce, sometimes uncontrollable emotions occasioned by the onset of love.

Jean Baptiste Poquelin, who took the stage name of Molière to spare his family embarrassment, began his career by adapting Italian farces for the French stage, imitating the improvisational style and character types of the *commedia dell'arte*. When finally he branched out, his satire was by no means tender: *Tartuffe* (1664) attacked false religiosity, and the darkly philosophical *Don Juan* (1665) provoked a number of powerful enemies. Yet his comedies of character, such as *The Misanthrope* (1666), *The Miser* (1668), and *The Imaginary Invalid* (1673), together with the neoclassical comedy *Amphitryon* (1668), the comedy-ballet *The Bourgeois Gentleman* (1670), and his continuing output of farces, established him as France's leading comic playwright.

Restoration and 18th-Century Drama

In the wake of Charles II's return (1660) from exile in France, John DRYDEN, in his "Essay of Dramatic Poesy" (1666), defended the new English standards for drama but paradoxically affirmed the strength of the French neoclassical ideal. The leading representative of RESTORATION DRAMA, Dryden advanced virtually every style dear to the era: heroic tragedy, written in rhymed couplets to approximate the French alexandrine meter; blank-verse tragedy, notably *All for Love* (1677), that followed all the neoclassical rules of unity and decorum; and the comedy of manners, the hallmark of the Restoration stage.

Owing much to Molière, the English comedy of manners was typically a witty, brittle satire of current mores, especially of relations between the sexes. Among its leading examples were Sir George ETHEREGE's *She Would If She Could* (1668) and *The Man of Mode* (1676); William WYCHERLEY's *The Country Wife* (1675); William CONGREVE's *The Way of the World* (1700); and George FARQUHAR's *The Recruiting Officer* (1706) and *The Beaux' Stratagem* (1707).

The resurgence of Puritanism, especially after the Glorious Revolution of 1688, had a profound effect on 18th-century drama. Playwrights, retreating from the free-spirited licentiousness of the Restoration, turned toward softer, sentimental comedy and moralizing domestic tragedy. George LILLO's *The London Merchant* (1731) consolidated this trend. SATIRE, however, enjoyed a brief revival with Henry FIELDING and John GAY, whose *The Beggar's Opera* (1728) met with phenomenal success. Their wit, however, was too sharp for the government, which retaliated by imposing strict censorship laws in 1737. For the next 150 years, few substantial English authors bothered with the drama. Notable exceptions were Oliver GOLDSMITH, author of *She Stoops to Conquer* (1773), and Richard Brinsley SHERIDAN, author of *The Rivals* (1775) and *The School for Scandal* (1777).

In 18th-century France, despite the efforts of VOLTAIRE and DIDEROT, neither advanced the cause of tragedy much, and in comedy only two writers stand out: MARIVAUX, whose wit and fancy transcended his sentimentality, and BEAUMARCHAIS, whose *The Barber of Seville* (1775) and *The Marriage of Figaro* (1784) restored laughter and satire to the French stage.

The Romantic Rebellion

The Germans, in attempting to build a theatrical heritage, originally looked to the French for their models. Gotthold LESSING, however, swayed Germany away from neoclassicism toward a sentimental bourgeois drama in the English style through his criticism, especially the *Hamburg Dramaturgy* (1767–68), and the success of his own plays.

A more complete rupture with the classical ideal was effected by the STURM UND DRANG (Storm and Stress) playwrights, who, taking Shakespeare as their model, fashioned sprawling dramas extolling nature, emotionalism, and freedom as opposed to the prevailing 18th-century values of civilization, rationalism, and order. Two of the leading Sturm und Drang playwrights, Johann Wolfgang von GOETHE and Friedrich SCHILLER, later turned to a new sort of classicism that was based more on their studies of classical history than on French models. Its notable exponents included Goethe's *Iphigeneia in Tauris* (1787) and Schiller's *Mary Stuart* (1800). Goethe's great dramatic poem FAUST, however, remains virtually unproducible in the theater because of its sheer size and scope.

During the heyday of German ROMANTICISM, in the early 19th century, the most daring and enduring playwriting took place entirely outside the movement, in works of Heinrich von KLEIST, Franz GRILLPARZER, Georg BÜCHNER and Christian Dietrich Grabbe.

Only in France did romanticism emerge as a serious dramatic form. In 1830, in the staid, traditionalist hall of La COMÉDIE FRANÇAISE, Victor HUGO's *Hernani* provoked a riot between romantics and conservatives because of its metrical irregularities, disregard for Aristotelian unities, and deliberate violation of accepted standards of decorum. Alexandre DUMAS *père* in *The Tower of Nesle* (1832), Alfred de MUSSET in *Lorenzaccio* (1834), and Alfred de VIGNY in *Chatterton* (1835) maintained the vogue for romantic drama for a brief while.

The more popular drama of the day was MELODRAMA, a debased version of romanticism that relied on spectacle, improbable plot twists, and simplistic moralism to titillate and captivate a vast public. Dion BOUCICAULT, August von Kotzebue, and Guilbert de Pixérécourt were the most successful and prolific practitioners.

Relying on melodrama's love of intrigue and the sordid, a number of French writers fashioned a more serious kind of prose drama. Eugène SCRIBE pioneered the "well-made play," a genre more notable for its craftsmanship than its profundity. Others pledged their faith in realism. *The Lady of the Camellias* (1849) by Alexandre DUMAS *fils*, for instance, caused a scandal because of its sympathetic treatment of a prostitute, and Victorien SARDOU entranced audiences with scenes of intense emotionalism enacted in accurately depicted milieus.

The Modern Drama

Henrik IBSEN is commonly seen as the father of modern dramatic REALISM, a creator of well-made plays suffused with a burning social consciousness. Although *The Pillars of Society* (1877), *A Doll's House* (1879), and *Ghosts* (1881) are in this vein, Ibsen's career also encompassed Norwegian historical pageants, romantic verse drama, and late idiosyncratic plays, like *The Master Builder* (1892), that blended the realistic with the visionary and symbolic.

Building on and altering a tradition that included the works of Nikolai GOGOL and Ivan TURGENEV, the Russian Anton CHEKHOV wrote four major plays—*The Sea Gull* (1896), *Uncle Vanya* (1899), *The Three Sisters* (1901), and *The Cherry Orchard* (1904)—that are still regarded as the most important works of the realistic movement.

The first performance of Victor Hugo's verse drama Hernani *on Feb. 25, 1830, provoked a riot between the neoclassicists and the romantics.*

Produced by the Moscow Art Theater, all contain elements of farce, symbolism, and poetry as well as realism, so that Chekhov, like all great artists, defies precise classification.

In London, George Bernard Shaw, an early champion of "Ibsenism," responded most fervently to the Norwegian's social consciousness. A Fabian Socialist, Shaw combined his critic's insight into dramaturgy with his Irish humor to create dozens of pleasant, witty, erudite dramatic discussions aimed at satirizing and altering the ways of the world. Less innovatively, Sir Arthur Wing Pinero, in *The Second Mrs. Tanqueray* (1893), and John Galsworthy, in *Strife* (1909) and *Justice* (1910), also gave realistic expession on the stage to important contemporary social problems.

The reaction of Sweden's August Strindberg to Ibsen was considerably more complex, determined largely by the miasmic turbulence of his shattering psyche. Ibsen's stylistic advances were important to his work, but Strindberg felt personally threatened by Ibsen's social ideas, especially by those about women. A few years after *The Father* (1887) and *Miss Julie* (1888), Strindberg moved from this fertile realistic period into self-exploration, plumbing his subconscious and searching for dramatic forms to express his dreams, fears, and feelings of guilt. With *A Dream Play* (1902), Strindberg's techniques became virtually expressionistic.

In Paris, both major independent theaters claimed Ibsen and Strindberg as their own. However, one leaned toward naturalism, following the path of Émile Zola, the other toward a drama of symbolism, such as *Pelléas et Mélisande* (1892), by the Belgian Maurice Maeterlinck. In 1896 the antinaturalistic Théâtre de l'Oeuvre produced Alfred Jarry's *Ubu Roi*, which was to inspire generations of avant-garde dramatists in France.

A fervent believer in the independent theater movement, William Butler Yeats, together with a group of like-minded intellectuals, in 1899 launched the Irish Dramatic Movement, which rejected Ibsenism and English models in favor of native Irish themes and poetic modes. The Abbey Theatre, which they founded, presented such plays as *Riders to the Sea* (1904) and *The Playboy of the Western World* (1907) by John Millington Synge, as well as the mystically poetic works of Yeats himself, who occasionally turned to the Japanese No drama in search of new models. Such later writers as Sean O'Casey and Brendan Behan continued to delve into the Irish character, but with a more sociopolitical orientation.

Like Strindberg, the Italian novelist and playwright Luigi Pirandello extended Ibsen's questioning into the identity of the human personality. In Pirandello's world, nothing is fixed, consistent, or certain. In several of his plays—*Right You Are If You Think You Are* (1917), *Six Characters in Search of an Author* (1921), *Henry IV* (1922), and *Tonight We Improvise* (1930)—Pirandello uses the theater itself as a metaphor for a world in which man is both himself and a fictitious character, and conflicting realities exist simultaneously.

In Germany, meanwhile, the expressionist playwrights grappled with the concept of the spiritual rebirth of humanity, the creation of "the new man." Theirs was a highly subjectivist approach that rejected the objectivity of realists and naturalists, such as Gerhart Hauptmann (*The Weavers*, 1893), to embrace the individualistic revolt of romanticism and the dramatization of the psyche pioneered in Strindberg's dream plays. Frank Wedekind foreshadowed the expressionist movement with his sexually shocking *Spring's Awakening* (1906). Bertolt Brecht, in *Drums in the Night* (1922) and *Baal* (1923), began his career as an exponent of expressionism, but moved on to the epic theater, in which he sought to subvert the normal expectations of dramatic literature by alienating his spectators, by refusing to allow them to be sucked into the action, forcing them instead to sit in judgment on it. In such plays as *Mother Courage* (1939) and *The Good Woman of Setzuan* (1943) and in collaborative works with the composer Kurt Weill—such as *The Threepenny Opera* (1928) and *Rise and Fall of the City of Mahagonny* (1930)—he analyzed the human dilemma through the filter of his idiosyncratic Marxism.

The earliest plays of Eugene O'Neill were produced in New York by the Provincetown Players, who consciously sought to create in the United States the equivalent of a European independent art theater. In bringing a new spirit of experimentation and seriousness of purpose to American drama, O'Neill alternately donned the mantles of the Greeks, the Russian realist Maxsim Gorky, Pirandello, Synge, and, most frequently, Strindberg in his expressionistic period.

The dramatic and theatrical world was upended at mid-century by the emergence in Paris of a number of highly individualistic writers who were later grouped together under the somewhat misleading rubric of "absurdism." Eugène Ionesco, a devoted admirer of Jarry, called his first play, *The Bald Soprano* (1950), an "anti-play," because it ridiculed all the conventions of drama, the theater, logic, language, and life; its very title is significant in that it is totally irrelevant to the action of the play. Jean Genet's revolt against society and the drama has

Bertolt Brecht's Mother Courage and Her Children *(1941) exemplifies the didactic dramas of protest termed* epic theater, *which seeks an intellectual response from the audience to arouse political or social awareness.*

none of the playfulness of Ionesco's. His is a theater of somber ritual in which the outcasts of society both mock and celebrate the orthodoxies that have oppressed them. After *The Screens* (1961), his vision of the end of colonialism in Algeria, Genet abandoned the theater entirely.

In 1953, *Waiting for Godot* appeared in Paris before a generally unimpressed and uncomprehending audience. In the subsequent years, however, this play has come to be recognized as one of the most significant artistic works of the century, and its author, Samuel BECKETT, as an innovative master of dramatic expression.

The two most popular serious American playwrights of the 1960s and '70s, Arthur MILLER and Tennessee WILLIAMS, wrote essentially in the traditions of Ibsen and Chekhov, although without their iconoclasm. Edward ALBEE's early one-act plays, which bear strong traces of both Beckett and Ionesco, brought a Parisian tinge of the avant-garde to New York, but his greatest popular success, *Who's Afraid of Virginia Woolf?* (1962), returned to the home base of psychological realism to achieve its harrowing power. Since the mid-1960s Sam SHEPARD has been delving into the mythic roots of American society, drawing from the drug culture and jazz, rock, and Western music to produce an idiosyncratic dramatic voice. In such plays as *Glengarry Glen Ross* (1983) and *Speed-the-Plow* (1988), David MAMET explored the fine line between standard business practices and sheer thuggery. African America found its most compelling dramatic voice in the work of August WILSON, who won the 1987 Pulitzer Prize for *Fences*. His major plays constitute a cycle, creating a history of African Americans through representative stories told with a spiritual lyricism.

In Britain, Harold PINTER, an admirer of Beckett, has generally used the living room as a chamber of nameless horrors; in such plays as *The Caretaker* (1960) and *The Homecoming* (1965) his distinctively elliptical dialogue evokes the underlying terror of everyday life. Writers with a stronger political orientation, from John OSBORNE to Edward BOND, have stripped away the facade of British society to expose the harsh economic, social, and political realities beneath.

In South Africa, Athol FUGARD has created a poetry of the trials of the human spirit in such plays as *Boesman and Lena* (1969), *A Lesson from Aloes* (1980), and *Master Harold . . . and the Boys* (1982).

The first major German-language playwrights to emerge after World War II, Max FRISCH and Friedrich DÜRRENMATT, are both Swiss followers of Brecht who have grappled with the moral implications of social and political action and inaction. Peter WEISS, in *The Persecutions and Assassination of Jean-Paul Marat As Performed by the Inmates of Charenton under the Direction of the Marquis de Sade* (1964), shows the influence of Brecht as well as of the "total theater" concepts of Erwin PISCATOR and the "theater of cruelty" of Antonin ARTAUD. In *The Investigation* (1965) Weiss presented the actual testimony of the overlords and victims of Auschwitz, using the techniques of documentary drama devised by Rolf HOCHHUTH for his controversial *The Deputy* (1963). In recent years the Austrian Peter HANDKE has been less concerned with politics than with finding new dramatic expressions of modern linguistic inquiries.

A hallmark of the 1980s has been a blurring of the distinctions between drama and the other elements of the theater. In *Einstein on the Beach* (1975), *the CIVIL warS* (1983), and *Alcestis* (1986), Robert WILSON creates a hallucinatory collage in which text, music, movement, and haunting visual imagery alternately collide and dovetail as if on independent trajectories. Bill Irwin, one of the "new vaudevillians," adept in mime, juggling, and eccentric movement, created an entire Broadway comedy—*Largely New York* (1989)—without the use of words.

See also: NARRATIVE AND DRAMATIC DEVICES; articles headed by THEATER as the first word (such as THEATER OF THE ABSURD); the literatures of the major European countries (such as RUSSIAN LITERATURE); and entries on many of the titles named in this article.

Dramamine see MOTION SICKNESS

Drang nach Osten

Drang nach Osten [drahng nahk aws'-ten] *Drang nach Osten*, meaning drive to the east, is the German phrase historians use for the movement of the medieval German people into east central Europe as colonists, merchants, missionaries, and conquerors.

One route of the German advance eastward flowed down the Danube into and beyond AUSTRIA. Another advanced from SAXONY across the Elbe to the Oder and into SILESIA. A third, represented by the commercial HANSEATIC LEAGUE and the military religious orders of TEUTONIC KNIGHTS and Livonian Knights, followed the Baltic coastline into LIVONIA and PRUSSIA. The *Drang nach Osten* created the myth of German superiority over the Slavs and thus contributed to the *Lebensraum* idea of German NAZISM and to the German invasions of Poland and Russia in World War II.

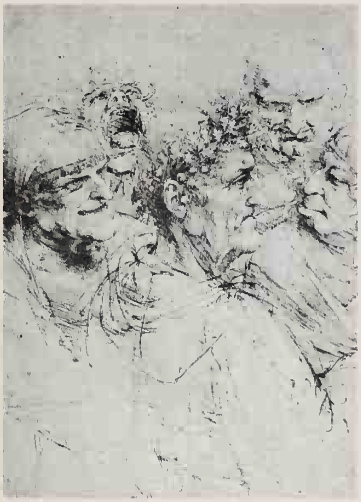
Draper, John William The English-born American chemist John William Draper, b. May 5, 1811, d. Jan. 4, 1882, is known for his early work in photography. From 1839 until his death he was professor of chemistry at New York University, where he also organized a medical school, of which he served as president from 1850. In 1837, two years before Louis DAGUERRE announced his process for fixing images with a camera, Draper discovered that photographs could be made by the action of light on sensitized surfaces. He was among the first to make a photograph of an individual (1839), of the Moon (1840), and of objects through a microscope (1850).

Dravidian languages [druh-vid'-ee-uhn] The Dravidian languages, with more than 165 million speakers, constitute a major language family in the southern part of India, northern Sri Lanka (formerly Ceylon), and other parts of South Asia. Dravidian was labeled as a distinct language family by the British linguist Robert Caldwell in 1856. The name *Dravidian*, coined by Caldwell, was derived from the Sanskrit word for Tamil, one of the principal Dravidian languages.

Three subfamilies of Dravidian are recognized. South Dravidian includes Tamil, Malayalam, and Kannada, as well as several nonliterary languages, with a total of more than 100 million speakers in the southern parts of India and adjoining areas of Sri Lanka. Like Sanskrit for the Indic languages, the literature of Tamil dates from the pre-Christian era. Central Dravidian consists of Telugu, the only literary language in this group, and several spoken languages, with a total of about 53 million speakers in central India. North Dravidian includes Kurukh, Malto, and Brahui, with more than 2 million speakers in Pakistan, Afghanistan, and the border areas of India.

drawing Drawing is the representation of images or symbols on paper or some other two-dimensional markable surface, using a firm instrument such as a pencil, crayon, chalk, charcoal, or pen and ink. In the purely creative arts, the drawing was traditionally a preliminary work, used in preparing a finished work of painting or sculpture. Drawings conceived as finished artistic products became common only in the 18th and 19th centuries. In addition to being a purely aesthetic exercise, drawing is the art of the draftsperson, who prepares precise architectural or mechanical plans using devices such as rulers, T squares, and compasses to ensure accuracy.

Drawing Media and Techniques. Charcoal or charred wood is probably the oldest drawing material, and the use of natural chalks may also date to prehistoric times. In the Renaissance period chalk was combined with clay to make it less friable and easier to handle. PASTELS were invented in the 18th century by using sticks of powdered pigments bound with gum. In the same period, crayons were developed when chalk and pigment were blended with fatty materials like wax and then formed into sticks. The waxy appearance of crayon drawings helps to solidify forms and create a luminous, smooth surface.

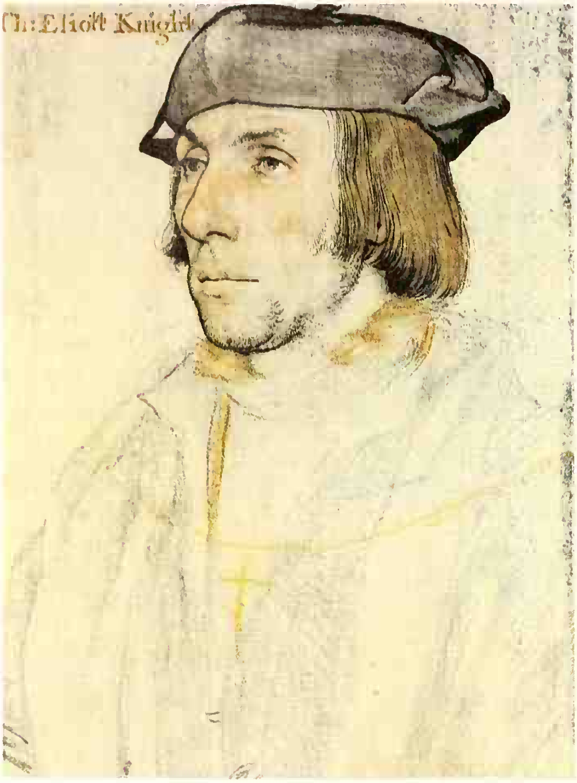

Leonardo da Vinci's drawing (c. 1494) of five grotesque heads reveals the precise and expressive treatment of physiognomy and facial expression characteristic of his numerous anatomical studies. (Royal Library, Windsor Castle.)

During the Middle Ages and early Renaissance a sharp pointed rod of silver, gold, copper, or lead was used in metalpoint, an exacting technique that encourages a meticulous use of line, discerning detail, and delicate tonal relationships. Beginning in the 17th century metalpoint began to be replaced by graphite and pencil. Graphite had the advantage of not requiring a specially prepared surface, and it could be erased easily. The wood-encased pencil was invented and mass-produced in the 19th century; its economy, ease of handling, and variety of effect all contributed to its universal popularity as a medium.

Reed pens were used for drawing in antiquity. The earliest extant pen drawings are early medieval book illustrations, such as those for the *Utrecht Psalter* (9th century). The medieval reed pen was replaced in the Renaissance by the more versatile quill, or feather pen, which continued to be used until the 19th century, when the metal nib pen began to be mass-produced. Twentieth-century artists have employed ballpoint and felt-tip pens. Since the 15th century, pen drawings often have been enhanced by washes of ink or watercolor.

Drawings have usually been done on paper since the 15th century. Better drawing paper often has been handmade to ensure strength, variety of surface texture, and prevention of yellowing or discoloration. Pale-tinted blue, pink, beige, and gray papers were commonly used for coloristic effect between the 15th and 19th centuries.

Drawing in Art History. Being allied to initial efforts at communication, drawing is probably the earliest of the visual arts. As they began to learn about natural pigments, prehistoric humans were able to draw figures on stone and clay and on cave walls. The drawing styles of the ancient Mediterranean world are evident in Egyptian wall paintings, Mesopotamian incised ornamentation, and Aegean and Greek ceramics. Ancient Near Eastern and Egyptian drawing was stylized because of an adherence to strictly observed artistic conventions. Images on black-



Hans Holbein the Younger's preparatory drawing (c. 1531) of Sir Thomas Elyot is typical of the artist's subtle portraits. (Royal Library, Windsor Castle.)

figure, red-figure, and white-figure vases indicate the Greek emphasis on freehand drawing and individualization of style.

The drawing of cartoons became important in the later Middle Ages and the Renaissance. These were full-sized models on paper used for weaving tapestries, making stained glass, and painting murals. During the late Gothic and Renaissance periods drawing achieved new freedom. Concern with individuality and experimentation prompted the development of personal styles, and new materials and subject matter allowed for more technical and interpretive variety.

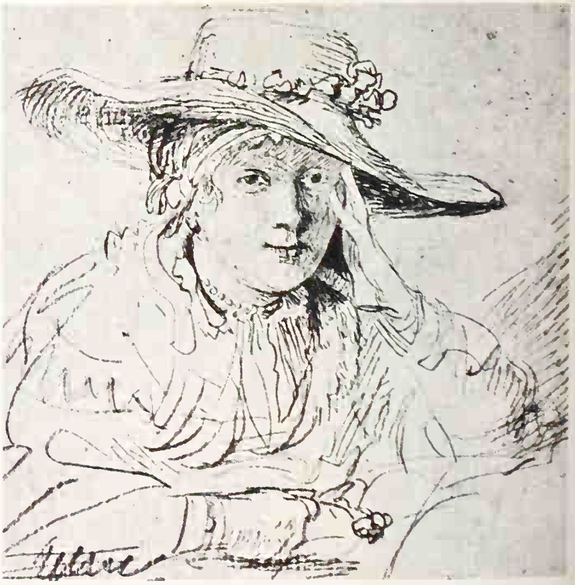
The Renaissance emphasized life studies and used chiaroscuro, or light and dark, to model figures and give textural variety. Sfumato was a subtle chiaroscuro variant devised by Leonardo de Vinci. This technique created a mysterious, pervasive haziness resulting in formal and emotional ambiguity. Most of the major drawings of Michelangelo, Raphael, and Tintoretto were figure studies, which were the most common Renaissance drawing subject. Portraiture reflected the Renaissance concern with the individual. Initially drawn in profile, more-complex three-quarter and frontal poses later became popular. Many 15th-century portraits were preliminary studies for paintings. By the 16th century, however, use of colored chalks to enhance monochromatic images indicates the growing artistic independence of portrait drawing. Renaissance empiricism, or study of nature, stimulated an interest in drawing landscapes and genre studies, or depictions of daily life.

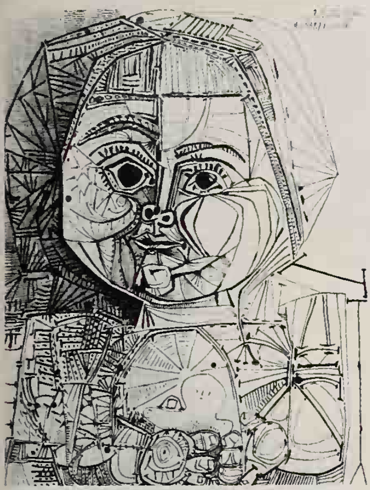
By the 16th century drawings began to be collected seriously, and the Italian artist Giorgio Vasari wrote about them critically, thereby furthering the medium's status. Rembrandt was probably most responsible for furthering the concept of drawings as independent works of art revealing the creative process and inner essence of the subject.

The delicate technique and color of 18th-century rococo style favored inference in line and theme, as in the soft, sensual sketches of Antoine Watteau and François Boucher. Linear purity returned with the advent of neoclassicism later in the century. Collecting drawings became an 18th-century fashion: drawings of landscapes and sites were the tourist snapshots of the time.

In the 19th century, drawing cartoons and caricatures for periodicals and illustrating news stories provided work for many artists, among them Honoré Daumier, Gustave Doré, and Winslow Homer. The aesthetics of classicism, romanticism, and realism stylistically coexisted in the first half of the century. Satiric intention and emphatic line distinguished the brutal realism of Francisco Goya's social commentaries. Art academies rigorously drilled their students in draftsmanship; as a result, some of the most technically proficient drawings in the

Rembrandt's silverpoint drawing (1633) of Saskia, his first wife, displays the precise line characteristic of the medium. Silverpoint technique, in which a metal-tipped pencil lightly incises a coated and tinted paper, requires exact execution because the surface restricts erasure. (Staatliche Museen, Berlin.)





Paloma (1953), Pablo Picasso's whimsical pen-and-ink drawing of his daughter, resembles his post–World War II sculpture and paintings in its playfulness and faceted form. (Private collection.)

history of art were produced by these academic realists.

Increased technical and stylistic individuality characterize drawing in the second half of the 19th century. The immediacy of impressionism encouraged suggestively rendered sketches describing personality or intimate aspects of daily life, as in the telling sparseness of Edouard Manet's black-chalk and pencil sketches or the rich coloristic complexity of Edgar Degas's pastels. Ornamental line and decorative effect were emphasized by Art Nouveau artists such as Aubrey Beardsley.

With the advent of postmodernism, architects such as Stanley Tigerman have prided themselves as much on their drawings as on their architectural designs. Drawing has been incorporated in many multimedia ventures, such as sculpture installations, manipulated photographs, and animated films.

In the 20th century, drawing has been considered the most intimate and revealing act of an artist. Pablo Picasso was master of the traditional and creator of the innovative—the variety, quantity, and quality of his works have earned him widespread acclaim as the most diverse and accomplished draftsperson of modern art.

The 1960s were marked by a major revival of drawing among the minimalists and conceptualists. They used the medium to conceive and record frequently temporal objects and installations or to give form to their ideas. Extending back to Paul Gauguin, "naive" drawing and "primitivism" were revived in the 1970s and '80s by neofigurative and neoexpressionist artists, who used an untutored technique directed by urgent emotions to express personal obsessions.

drawing and quartering Drawing and quartering was a punishment for treason in medieval and early modern England. In one form the condemned person was dragged to the gallows, hanged by the neck briefly, and, while still alive, disemboweled (drawn). Then the entrails were burned and the body divided into four parts. Edward Marcus Despard and six accomplices, convicted of conspiracy to assassinate George III in 1803, were the last persons to be executed in this way. The penalty was abolished in 1870.

Drayton, Michael The English poet Michael Drayton, b. 1563, d. Dec. 23, 1631, best known for "Since there's no help, come let us kiss and part" from the sonnet sequence *Idea's Mirror* (1594–1619), was a disciple of Edmund Spenser, as can be seen in his pastoral *The Shepherd's Garland* (1593).

Several of Drayton's poems are engagingly patriotic, such as the odes "To the Virginian Voyage" and "The Ballad of Agincourt" (1606). The epic *Poly-Olbion* (1598–1622) is a "chorographic description" of Britain's world of nature, intermixed with folklore (including the story of Lady Godiva). *England's Heroical Epistles* (1597–99) comprises rhymed-couplet letters from 12 pairs of English lovers. *Nymphidia* (1627) is a delightful poem set in a fairy kingdom.

Dreadnought see BATTLESHIP

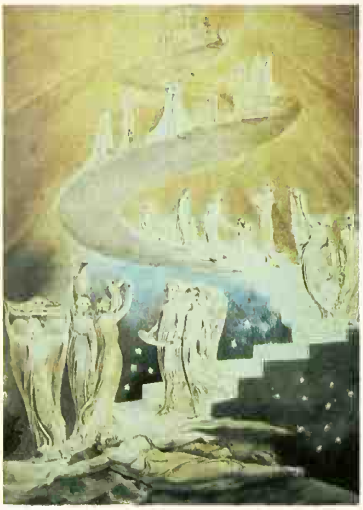
dreams and dreaming Dreaming is generally defined as imaginal, sensory, motor, and thought processes occurring during sleep. Neither sleep nor dreaming, however, can be precisely defined. What is called dreaming depends on how it is measured and in which of the four basic stages of SLEEP it occurs. Dreaming takes place in varying degrees in all stages of sleep. Dreams are not necessarily visual imagery; congenitally blind people dream in auditory and sensory-motor modes. One difference between waking and dreaming consciousness is that the latter tends to be an internal hallucinatorylike experience disconnected from the external world.

History

Dreaming has always been the subject of controversy. Egyptian papyrus documents dating back to 2000 BC discuss dreams and their interpretations. In ancient Greece the dreamer was believed to be in contact with the gods. In Homer's *Iliad* (*c*.800 BC), for example, dreams were considered messages from the gods.

In succeeding centuries Hippocrates, Aristotle, and Galen believed that dreams often contained physiological information that heralded future medical illnesses. Artemidorus (AD *c*.150) documented and interpreted thousands of dream reports in his book *Oneirocritica* (a combination of the Greek *oneiros*, "dream," and *kritikos*, "critical"). Unlike his predecessors, Artemidorus maintained that symbols in dreams did not have one universal meaning. These early scientific views, however, were abandoned, and no progress was made in dream study until the late 1800s.

In 1900, Sigmund FREUD ushered in the modern age of dream research in his monumentally original book *The Interpretation of Dreams*. According to Freud, dreams are disguised thoughts from the unconscious mind. He de-



Jacob's Ladder, *a watercolor by William Blake, shows a sleeping patriarch and his vision of angels ascending and descending the ladder to heaven. Such "message" dreams, in which a revelation is given or a prophecy symbolized, are common in both ancient and religious literatures. (British Museum, London.)*

veloped an elaborate theory of dreaming and how the mind works while asleep. Carl JUNG, an early student of Freud, broke with his teacher in insisting that the surface content of dreams is the meaning and that deep symbolic interpretation has little importance. (See also PSYCHOANALYSIS.)

REM Sleep

In 1953 sleep researchers led by Nathaniel Kleitman made the important discovery of rapid eye movement—or REM—sleep. Curious about the long-standing observation that the eyeballs of sleeping subjects in both humans and animals periodically move during sleep, they connected sleeping laboratory subjects to equipment that measured brain waves (yielding an electroencephalogram, or EEG), muscle tone (electromyogram, or EMG), and eye movement (electroculogram, or EOG). About 90% of the time when subjects were awakened during REM sleep, they reported a dream (whereas about 60% of non-REM awakenings resulted in reports of dreamlike activity).

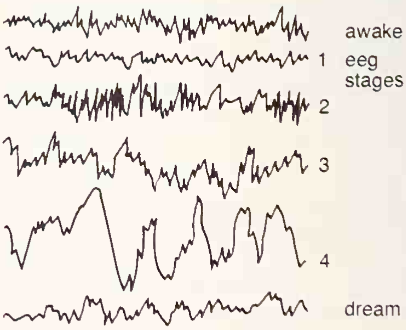
Prior to laboratory REM research, it was not known how frequently humans dreamed. Some theories even held that dreaming was a sign of mental disturbance. With laboratory REM research, however, subjects can be awakened after each REM period in order for researchers to extensively sample most mental activity that occurs during sleep. Humans, it was discovered, and all mammals—except the echidna, or spiny anteater, and perhaps the duckbilled platypus—dream every night. In adult humans these dreams begin about 90 minutes after the sleep begins and recur about 90 minutes apart with increasing length, for a total of nearly 2 hours of REM dreaming per night. With approximately five dreams a night, humans will have about 136,000 dreams in a lifetime, spending the equivalent of six years in an REM dream state.

This subject's sleep responses are being recorded. Electrodes attached to his scalp monitor brain-wave activity; electrodes placed on other parts of the body monitor physiological changes.

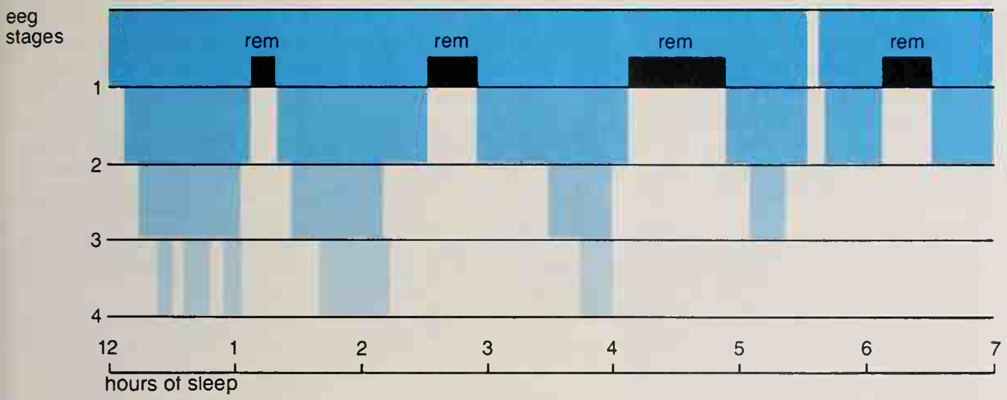
During REM dreaming the dreamer experiences increased heart rate, respiration, blood pressure, muscle twitches (myoclonic jerks), oxygen consumption, gastric secretions, and penile erections. REM sleep is called paradoxical sleep because it is characterized as being both light and deep sleep: using EEG measurements, it is light sleep (stage I); using EMG measures, it is deep sleep (stage IV), because for the most part, large voluntary muscles are paralyzed to prevent dreamers from physically acting out their dreams.

For a newborn, REM sleep constitutes 50% of sleep. This level gradually decreases to a stabilization level of 20 to 25% at adolescence. It reaches a low of 18% during old age. The severely mentally retarded and those with extremely low I.Q. spend less time in REM sleep than normal subjects. Variations in REM sleep also occur with some kinds of mental disorders.

There seems to be a biological and a psychological need for REM sleep, though it is not clear why. Subjects who are deprived of REM sleep for a night by constant awakening upon entering each REM cycle increase their REM sleep the following night. This is called the REM rebound effect. REM rebound is not due to simply losing sleep from being awakened, for nearly total REM deprivation can be achieved through administration of the drug Nardil (an antidepressant). Despite the apparent need for REM sleep—and contrary to early findings—no serious mental effects seem to result from REM deprivation, at least within a six-month time span. In fact, depriving some depressed people of REM dreaming actually alleviates their depression. Many drugs, including alcohol and



Brain waves are recorded on an electroencephalograph (EEG); each sleep stage has a distinct wave pattern, including dreaming during Stage 1.



Sleep occurs in cycles that repeat about every 90 minutes. As seen in this sleep pattern for a typical night, the duration of each stage varies from cycle to cycle. The sleeper descends to Stage IV and approximately 80 to 90 minutes later returns to Stage I, or REM sleep, when most dreaming occurs.

antihistamines, decrease REM sleep (as well as stage IV sleep).

Biological and Psychological Theories

Theories attempting to explain the origin and functions of REM sleep include: (1) that REM sleep provides stimulation for the development of the brain; (2) that it performs a chemical restoration function, since during REM dreaming neuroprotein synthesis occurs along with the restoration of other depleted brain chemicals; (3) that it provides oculomotor (eye movement) coordination, since during non-REM sleep the eyes move independently of each other; (4) that it provides a vigilance function, since REM sleep (stage I) is characterized by a level of consciousness close to the awakened state; (5) in a more recent and controversial theory, that REM dreaming performs a neurological erasure function, eliminating extraneous information build-up in the memory system; and (6) that, in a more cognitive psychological explanation, REM dreaming enhances memory storage and reorganization.

Contrary to popular belief, dreaming is not caused by eating certain foods before bedtime, nor by environmental stimuli during sleeping. Dreaming is caused by internal biological processes. Some researchers have proposed the activation-synthesis hypothesis. Their neurological research indicates that large brain cells in the primitive brain stem spontaneously fire about every 90 minutes, sending random stimuli to cortical areas of the BRAIN. As a consequence, memory, sensory, muscle-control, and cognitive areas of the brain are randomly stimulated, resulting in the higher cortical brain attempting a synthesis of the random information in order to make some sense of it. This, according to the research, gives rise to the experience of a dream.

Now, as in the past, the most significant controversy centers on the question of whether dreams have intentional, or actual personal, meaning. Many psychotherapists maintain that while the neurological impulses from the brain stem may activate the dreaming process, the content or meaningful representations in dreams are caused by nonconscious needs, wishes, desires, and everyday concerns of the dreamer. Thus, such psychotherapists subscribe to the phenomenological-clinical, or "top-down," explanation, which holds that dreams are intentionally meaningful messages from the unconscious. The neurological, or "bottom-up," explanation maintains that dreams have no intentional meaning. A content analysis simply describes and classifies the various representations in dreams, such as people, houses, cars, trees, animals, and color, though no deep interpretation is attributed to the content. Differences in content have been discovered between the dreams of males and females, and between dreams occurring in different developmental stages of life.

Current Research

Some recent research seems to indicate that dream content reflects problems that the dreamer experiences in life, and that the function of such dreams is to facilitate the emotional resolution of the problems. Numerous accounts exist of scientific problems being resolved, and literary works being developed in dreams after dreamers had consciously immersed themselves in a problem for an extended time.

Cognitive psychologists are concerned with logic and thought processes during dreaming, and how they are different from mental processes during the waking state. In studies of the developmental cognitive processes of children's dreams, for instance, it has been found that the increasing complexity of children's dreams parallel waking cognitive development. Many researchers believe that knowledge about dreaming is important for understanding waking imagination.

Current research embraces all of the above areas. Anthropologists are studying cross-cultural similarities and differences in dreams. Research into NIGHTMARES continues. Bizarre dreams, which are not as common as traditionally believed, are under study, as are claims of EXTRASENSORY PERCEPTION effects in dreaming. In addition, REM research is proving important for understanding psychobiological abnormalities. Some findings indicate that epileptic seizures are suppressed during REM sleep. Narcoleptics, people who may involuntarily fall asleep at any time, enter REM sleep almost immediately. Research continues on variations in dream recall. Artists, for instance, tend to recall more dreams than scientists; and, for most people, only a small percentage of dreams are recalled.

Lucid dreaming, the ability of dreamers to become aware of and to control their dreams while dreaming, is also the focus of some current research. Some lucid dreamers can learn to communicate with researchers through nonverbal signals. New research also promises to yield significant knowledge about memory storage and retrieval, cognitive organization, psychobiological processes, human consciousness, and specific operations of the mind.

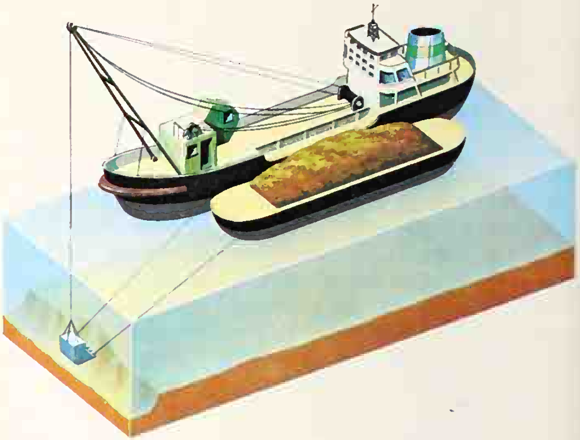
Dred Scott, an American slave, sued for his freedom from 1846 until the case was dismissed by the U.S. Supreme Court in 1857. The Court's decision reiterated that no black had U.S. citizenship and struck down the Missouri Compromise (1820) as unconstitutional.

Dred Scott v. Sandford The decision of the Supreme Court of the United States in *Dred Scott* v. *Sandford* (1857) held that a black slave could not become a citizen under the U.S. Constitution. Dred Scott (*c.*1795–1858), a slave in Missouri, had been taken by his owner, John Emerson, into Illinois, where slavery had been prohibited by the Northwest Ordinance of 1787, and into the Louisiana Territory, where slavery was forbidden by the MISSOURI COMPROMISE. After his return to Missouri, Scott brought suit (1846) against Emerson's widow, claiming that he was free by reason of his residence in free territory. The Missouri supreme court ruled against him, but after his ownership was transferred to Mrs. Emerson's brother, John F. A. Sanford (the name was misspelled in legal records) of New York, Scott brought a similar suit in federal court, based on diversity of state citizenship. That court found (1854) that Scott was Sanford's slave, but Scott's lawyers appealed to the Supreme Court, which finally heard the case in 1856–57.

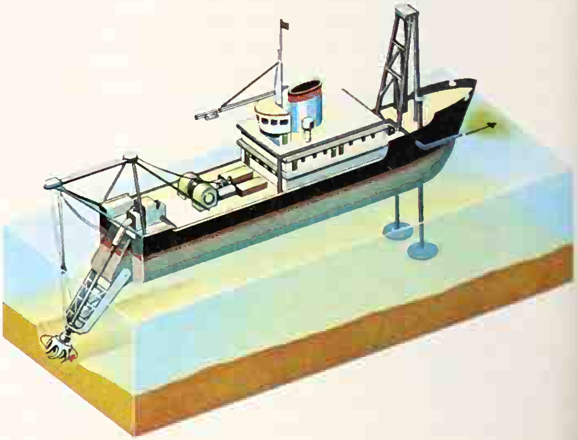
The court's decision, reached by a seven-to-two vote, was that Scott was not a citizen and thus had no right to sue in the federal courts. Chief Justice Roger B. TANEY delivered the majority opinion, in which he made three points. First, he observed that blacks—slave or free—were not included in the category of "citizen" as the word was used in the U.S. Constitution for the purpose of suing in the federal courts. Second, Scott had not become free by virtue of his residence in a territory covered by the Missouri Compromise, since that legislation was unconstitutional. Third, whatever may have been the temporary effect of Scott's sojourn in Illinois, Scott had ultimately returned to Missouri, where his status depended on Missouri law. This was viewed as a proslavery decision by the abolitionists, and the case probably hastened the coming of the Civil War.

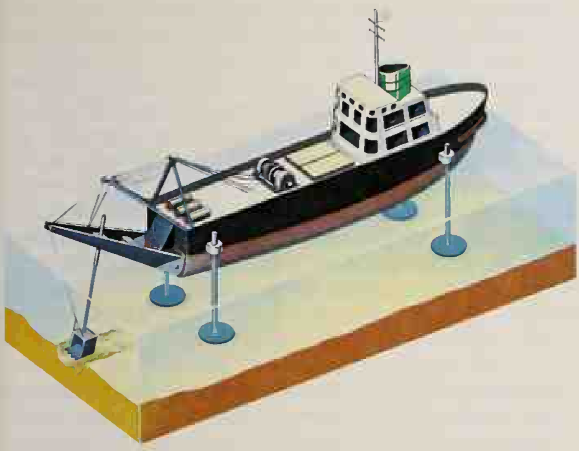
dredging Dredging involves excavating a river, canal, or harbor bed and removing the excavated underwater sand or stone. It is undertaken to increase or maintain water-channel depth; to drain and supply fill for marshes and lowlands; to build foundations for dams, dikes, and bridges; and to recover underwater deposits, such as sand, minerals, shellfish, and fertilizers.

Mechanical human- or horse-powered dredging was developed in Europe in the late Middle Ages. The first

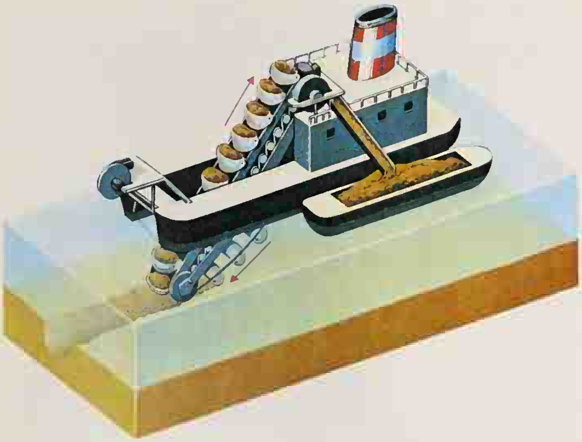


A scraper, or dragline, dredge carries a toothed bucket suspended by cables from the end of a swinging boom at the rear of the vessel and is dragged along a river or a harbor bed. Material scooped up by the bucket is raised by deck winches and emptied into a barge. (Below) *A cutter dredge uses a rotary cutter to loosen material in a channel bed. The material is drawn up through a suction pipe and discharged at a distance from the vessel. A two-legged bracing system at the bow stabilizes the dredger against the cutter's reaction force.*





A dipper dredge, the most common type of dredge, uses a toothed bucket at the end of a pivoted arm, which is supported and lifted by a rear boom. The bucket collects its load with a circular upward sweep. When dredging, the boat is held in place by heavy, extendable posts.



A bucket, or ladder, dredge uses a revolving chain of buckets that move around a rigid, ladder-shaped frame. As the buckets revolve, material is scooped up from a river bed, carried to the top of the frame, and discharged through a chute into a waiting barge.

bucket-equipped, steam-powered dredge was built in 1804 by an American, Oliver Evans.

Modern dredges may be mechanical, hydraulic, or a combination of the two and may be powered by steam engines, internal-combustion engines, hydraulic systems, pneumatic systems, or electric power. Of the mechanical dredges, the dipper dredge is the most common. It has a hinged bucket-bottom that opens to release the load. The grab dredge—in effect, a derrick mounted on a barge—raises and lowers a bucket by flexible cables. The bucket dredge (or ladder dredge) is equipped with an endless chain of buckets. A scraper, or dragline, dredge carries a toothed bucket or scoop suspended from a swinging boom. The hydraulic, or suction, dredge operates by creating suction in a pipe by means of a centrifugal pump. Water and suspended solid material are drawn from the channel bed up through the pipe. In Europe the pump alone is usually sufficient for dredging; in the United States, it is often necessary to add a rotary cutter to loosen material on the bottom; such a system is called a cutter dredge. The scouring dredge loosens and lifts light soil from the bottom with a harrow so that water currents can float it away.

Dredging boats are usually accompanied by separate dumping scows. In the Netherlands, dredges have been used extensively for the construction operations of the DELTA PLAN.

See also: EARTH-MOVING MACHINERY; MINING AND QUARRYING

Dreiser, Theodore Theodore Dreiser, b. Terre Haute, Ind., Aug. 27, 1871, d. Dec. 28, 1945, the leading American exponent of literary NATURALISM, is best known as the author of SISTER CARRIE and *An American Tragedy.*

One of ten children raised in the slums of industrial Terre Haute, Dreiser early reacted against the Roman Catholicism of his father. A teacher recognized his talent and paid his expenses at Indiana University; Dreiser, however, left after a year (1889–90) and turned to journalism in Chicago, St. Louis, Pittsburgh, and finally New York City. At the urging of his brother Paul Dresser, a popular songwriter, he published his first novel, *Sister Carrie,* in 1900. It was immediately attacked as an immoral treatment of a scandalous woman's rise to success and sold only 456 copies. Through the help of friends he began working for *The Delineator,* a fashion magazine, and eventually became its editor from 1907 to 1910. His second novel, *Jennie Gerhardt* (1911), another sympathetic portrait of a fallen woman, was also considered immoral.

Probably because of his humble beginnings, Dreiser was ever fascinated by the uses and abuses of wealth and power. His so-called Cowperwood trilogy—*The Financier* (1912), *The Titan* (1914), and *The Stoic* (posthumously published in 1947)—was based on the life of the wealthy financier Charles T. Yerkes. After the failure of *The Genius* (1915), an autobiographical novel about power and sex, Dreiser again found himself embroiled in controversy. With *A Hoosier Holiday* (1916), a travel book, he turned to nonfiction, also writing *Twelve Men* (1919), a book of portraits; *Hey-Rub-a-Dub-Dub* (1919), an iconoclastic book of philosophy; and an autobiography, *A Book about Myself* (1922). His plays appeared in *Plays of the Natural and Supernatural* (1916) and *The Hand of the Potter* (1918), his short stories in *Free and Other Stories* (1918).

In 1925, Dreiser published *An American Tragedy,* widely regarded as his finest achievement. Based on the famous Gillette-Brown murder trial of 1906, the novel traces the fortunes of the ambitious but weak Clyde Grif-

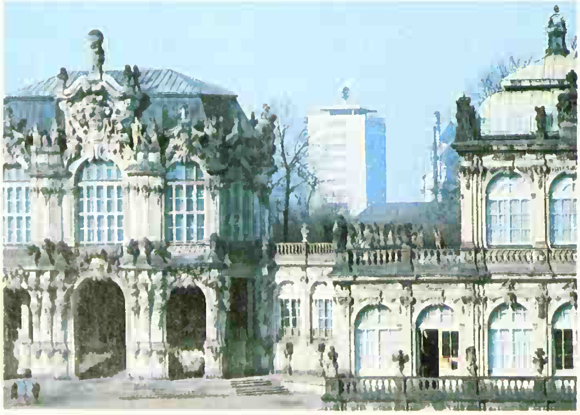
Theodore Dreiser, an American novelist, pioneered the literary movement known as naturalism. In such novels as Sister Carrie *(1900) and* An American Tragedy *(1925), Dreiser commented on the spiritual emptiness of individuals in a materialistic, industrial society.*

fiths in his unsuccessful search for wealth, recognition, and power. The book was a critical success; even those who belittled Dreiser's earlier books considered *An American Tragedy* the greatest novel of the age.

Dreiser traveled to Russia in 1927, which yielded *Dreiser Looks at Russia* (1928), and on his return became involved in socialist and radical causes. *Tragic America* (1931) and *America Is Worth Saving* (1941) are typical of his views on capitalism. In 1939 he moved to Hollywood, where he finished *The Bulwark* (1946) and *The Stoic.*

Dresden Dresden, which for several centuries was the capital of the historic German state of Saxony, is today the capital of the Dresden district (*Bezirk*) of Germany. The city is situated on the bend of the Elbe River, about 30 km (19 mi) from the northwestern boundary of Czechoslovakia. The majority of its 521,205 (1988 est.) residents are Protestants.

Dresden's Glockenspiel Pavilion (left) *is one of the few 18th-century structures to survive the Allied bombing during World War II. The complex was completed in 1722, when Dresden was the capital of the duchy of Saxony.*



Dresden lies on both sides of the Elbe River, with the "Old Town" on its left bank and the "New Town" on its right bank. It is surrounded by wooded hills, and its scenic beauty is enhanced by many public buildings, most of them fine examples of baroque and rococo architecture dating from the 17th and 18th centuries. Because of these architectural landmarks and its art treasures, especially the rich collection of Italian, Dutch, and Flemish paintings in the famous Semper Gallery, Dresden is often called the German Florence. The Zwinger Museum is noted for its numerous collections that include porcelain, minerals and gems, and scientific instruments. Dresden's legendary Semper Opera, destroyed during World War II, was restored and reopened in 1985.

Although the city's fame rests primarily on its past cultural achievements, Dresden is also a manufacturing center. Its products range from machinery, chemicals, cameras, and optical instruments to clothing, glassware, and foodstuffs. The city's best-known product is Dresden china. The city is also a major railroad junction and a busy river port.

The name Dresden is derived from *Drezdzane,* the Old Slavic word for forest people, who were early settlers in the area. The first documented mention of Dresden dates from 1216. The city became (1485) the permanent residence of the dukes of Saxony. In 1491 and again in 1685 much of Dresden was destroyed by fire. It developed rapidly in the last half of the 17th and the first half of the 18th century under Electors of Saxony Frederick Augustus I and II (Kings AUGUSTUS II and III of Poland). The Treaty of Dresden (1745) ended Prussian participation in the War of the Austrian Succession and Prussian occupation of the city. In 1813, Napoleon made the city his main base during his last great victory, the Battle of Dresden, in which he fought against the combined forces of Austria, Prussia, and Russia. In February 1945, Allied bomber raids killed about 135,000 people and destroyed many architectural landmarks. Extensive rebuilding has taken place since the end of World War II.

Dresden ware see POTTERY AND PORCELAIN

dress see COSTUME

dressage see HORSE SHOW

Drew, Daniel Daniel Drew, b. Carmel, N.Y., July 29, 1797, d. Sept. 18, 1879, was an American financier and stock manipulator who began in the livestock business, moved on to steamboat lines, and in 1844 established a Wall Street brokerage firm. With James FISK and Jay GOULD he waged (1866–68) a spectacular battle to prevent Cornelius Vanderbilt from gaining control of the Erie Railroad, of which Drew was treasurer and a director. The three issued large quantities of fraudulent, or "watered," stock during their successful struggle. In 1870, Fisk and Gould undermined Drew financially, and he lost the remainder of his fortune in the panic of 1873. In 1876 he declared bankruptcy. During his years of prosperity he contributed to the Methodist church and founded Drew Theological Seminary, now part of Drew University, Madison, N.J.

Drew, Nancy Nancy Drew is the heroine of a series of juvenile detective novels created in 1930 by Edward L. Stratemeyer (1862–1930) and continued after his death by his daughter, Harriet S. Adams, writing under the pseudonym Carolyn Keene. Popular with generations of American schoolgirls, the series has sold many millions of copies. In the stories, Nancy, the daughter of district attorney Carson Drew, solves crimes by her resourcefulness and knowledge of human character.

Drexel (family) **Francis Martin Drexel**, b. Austria, Apr. 7, 1792, d. June 5, 1863, emigrated to Philadelphia and founded (1838) a currency brokerage office that eventually became the world-famous banking house Drexel and Company. Francis had three sons, all of whom were bankers and philanthropists. The most notable, **Anthony Joseph Drexel**, b. Philadelphia, Sept. 13, 1826, d. June 30, 1893, founded the city's well-known Drexel Institute of Technology in 1892. His niece **Katharine Drexel**, b. Philadelphia, Nov. 26, 1858, d. Mar. 3, 1955, founded (1891) the Sisters of the Blessed Sacrament, a congregation of nuns dedicated to working among American Indians and blacks. Devoting her large fortune to her religious vocation, she helped build and maintain schools and convents in a number of states, as well as Xavier University in New Orleans. She was beatified by Pope John Paul II in 1988.

Dreyfus affair [dray'-fuhs] The Dreyfus affair began in 1894 when Capt. Alfred Dreyfus (1859–1935), an Alsatian Jewish officer on the French general staff, was falsely accused of giving information to the German military attaché in Paris. Subsequent efforts to exonerate Dreyfus led to a prolonged political crisis, perhaps the most important in the history of the Third Republic. The affair emphasized the conflicts between the republicans and the rightists, who wanted to reestablish the monarchy, and led to renewed hostility and conflict between the Roman Catholic church and the republic. It also showed the power of anti-Semitism in France.

The evidence presented against Dreyfus at his court-martial in October 1894 was insufficient. Nonetheless, he was convicted and sent to Devil's Island for imprisonment. Secrets continued to be passed, however, and another French officer, Maj. Ferdinand Esterhazy, was implicated. When the new chief of intelligence, Col. Georges Picquart (1854–1914), attempted to reopen the case in 1896, he was dismissed, but Dreyfus's brother succeeded in having Esterhazy brought to trial in 1897. Against all evidence, he was acquitted.

In January 1898 the novelist Émile Zola published an open letter entitled "J'accuse," attacking the army and bringing the matter to public attention. Dreyfus's cause was taken up by French radicals, socialists, and intellectuals. In 1898 the major document used against Dreyfus was proven a forgery. Dreyfus was tried again in 1899 and again found guilty. President Émile Loubet pardoned him, however, and in 1906 he was vindicated by a civilian court and readmitted to the army. The affair discredited the army, a bastion of the monarchists, and the Catholic church. As a result the radicals came to power, and France was able to develop a secular state, a bourgeois society, and a republican army.

Captain Alfred Dreyfus is stripped of his rank in the French Army after his controversial conviction for treason in 1894. The falsely accused Dreyfus was incarcerated for 4 years while his case became a cause célèbre in French politics.

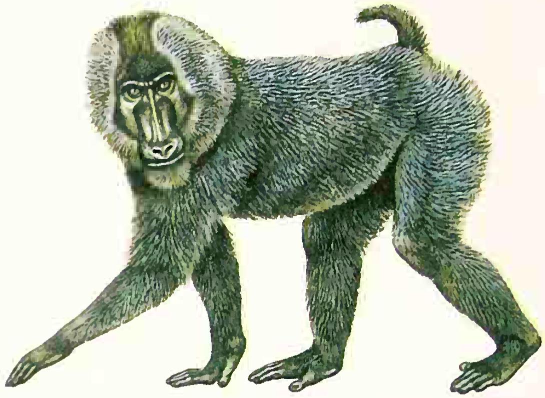
Dreyfuss, Henry [dray'-fuhs] Henry Dreyfuss, b. New York City, Mar. 2, 1904, d. Oct. 5, 1972, an American pioneer in industrial design, influenced the shape, feel, look, and in some cases the function of many manufactured objects used today.

Dreyfuss came from a family of theatrical costume designers and began his career by designing stage sets. His design studio, opened in 1929, was a success from its inception, since a Dreyfuss-designed product had a considerable competitive edge over a similar product whose design had been determined by manufacturing exigencies or for appearance alone. Telephones, refrigerators, typewriters, vacuum cleaners, gas stations, prosthetics, plumbing fixtures, farm machinery, magazines, ocean liners, and airplanes were all reshaped by Dreyfuss to conform to standards where function, safety, and ease of use were as important as appearance. Dreyfuss published his autobiography, *Designing for People*, in 1955. In 1972 he committed suicide in California.

drift, glacial Glacial drift is rock material transported by GLACIERS or meltwater derived from them, and also deposits in the sea predominantly of glacial origin. Included are unstratified drift, or TILL, and glacial stream sediments, glacial lake sediments, and iceberg-rafted debris in the oceans. A variety of glacial landforms, including several types of MORAINES and ESKERS, consist of drift deposited by ICE AGE and Holocene glaciers.

In regions once covered by Pleistocene glaciers, extensive areas sometimes lack glacial drift. In the United States a large driftless area covers southwestern Wisconsin and parts of Minnesota, Iowa, and Illinois.

drill The drill, *Mandrillus leucophaeus*, is a monkey belonging to the family Cercopithecidae, order Primates. The drill is about 76 cm (30 in) long, with an 8-cm (3-in) tail, and weighs about 23 kg (50 lb). Its coat is grayish brown, and the face purplish black, with a white beard and a crimson lower lip. The buttock pads are lilac with a reddish purple fringe; excitement heightens the colors. Drills live in the forests of equatorial West Africa, where they eat small animals, nuts, fruits, and various plants. Captive drills live 40 years or more.



The drill, related to the mandrill and the baboon, often lives in troops of a few adult males and several females and young. A forest dweller, it climbs trees only at night to sleep.

drilling Drilling is the process of producing a cylindrical hole in wood, metal, soil, or rock. The twist drill, most widely used in carpentry and metalworking, has two helical grooves running about three-fourths of the length of the drill and ending in two straight cutting edges, which allow chips to escape. Drills may be operated by hand or machine and are either straight or tapered. Straight-shank drills are gripped in a chuck (a centering and clamping device); tapered-shank drills are placed in matching holes in a drilling machine. The drilling machine is often a precision instrument capable of producing holes to very fine measurements. Instead of drills, some machines use abrasive slurries or electrochemical or electrolytic methods to shape holes (see MACHINE TOOLS).

Machines used in soil- or rock-drilling may be percussive—operating by intermittent impact—or rotary, with a cutting or grinding action; or they may be a combination of the two. In percussive drilling, often used to produce shallow holes, successive blows are applied to a chisellike bit. For deep boring, a drill is attached to hollow steel rods and impelled by rotary motion into the earth, with additional rods added as the hole deepens. Three types of bits are used in rotary drilling: drag bits, used primarily to cut soft rock; roller bits, with wedge-shaped teeth to crush harder rock; and diamond bits, to grind. The first steam-powered drill was invented by Richard TREVITHICK in 1813; the first compressed-air drill was produced in 1853. In early oil wells percussive drills caused spectacular gushers that wasted large amounts of oil. Rotary drilling is now used, with the well bore kept full of a mud mixture to prevent blowouts.

Many advances in drilling technique were made by TUNNEL engineers, who used drilling to place gunpowder charges during construction (1661–81) of the Canal du Midi tunnel in France. In drilling the first Alpine tunnel, the Mont Cenis (built 1857–71), a compressed-air drill mounted on a railroad carriage was used to drill blasting holes. Modern tunneling drills, mounted on large rigs called moles, are capable of boring the entire diameter of a tunnel in a single operation. The first mole was the Beaumont borer, a rotary drill devised in 1880 for a projected tunnel under the English Channel. In the 1880s a rock drill called a stoper, used for overhead drilling in mining, was the first drill to combine percussive action with pneumatic feed.

A rotary drill makes a ringlike hole. The excavated material, a cross section, or core, of sediments or rock strata, may be brought up through the hollow steel rods to which the core bit is attached. The samples provided are used in prospecting and geological studies. The international OCEAN DRILLING PROGRAM takes cores from the deep ocean floor, as did the preceding DEEP-SEA DRILLING PROJECT. The Soviet borehole in the Kola Peninsula, begun in 1970, is currently the world's deepest drilled hole, reaching more than 12,000 m (7.5 mi) into the Earth's crust to rocks as old as 2,700 million years.

See also: COAL AND COAL MINING; MINING AND QUARRYING; PETROLEUM INDUSTRY.

dromedary see CAMEL

dropsy see EDEMA

Drosophila see FRUIT FLY

Droste-Hülshoff, Annette Elisabeth, von [druhs'-te huls'-hawf] Annette von Droste-Hülshoff, b. Jan. 10, 1797, d. May 24, 1848, was one of the great German poets of her century. She lived an outwardly secure and idyllic, aristocratic life that concealed existential religious doubts and inner passion, especially for her protégé, Levin Schücking, her first biographer (1862) and 17 years her junior. Struggling and renunciation inspired great poems—published in 1838, 1844, 1851, 1860—in which lyrical strength, metrical freedom, realism, bold imagery, and symbolism anticipate later trends. *Die Judenbuche* (1842; *The Jews' Beech Tree*, 1958), her only completed prose work, is a landmark in the history of the novella.

drought [drowt] Droughts are periods of abnormally dry weather that are sufficiently prolonged for the lack of precipitation to cause a serious imbalance in the HYDROLOGIC CYCLE. They result in water shortages, crop losses, reduced streamflow, diminished groundwater resources, and depleted soil moisture.

Droughts are distinguished from dry spells, which are periods of approximately 14 days with little or no precipitation. They may be classified according to climate conditions in the affected area. Thus permanent droughts exist where the climate is perpetually dry and agriculture can be carried out only with constant irrigation. Seasonal droughts exist where wet and dry seasons regularly alternate and farming, if done during the dry season, must also rely on irrigation. Contingent, or unpredictable, droughts exist where normally expected rainfall fails to occur, most characteristically in humid and subhumid areas; they tend to be most severe when they coincide with the increased water needs of the growing season and are thus the most serious of the physical hazards to farming. A fourth type of drought, called invisible drought, is harder to recognize. It occurs where precipitation fails to counterbalance the moisture lost by crops through evapotranspiration, and it makes itself felt by reduced crop yields rather than by wilting or some other observable form of crop damage.

Permanent drought occurs in two broad belts of high baro-metric pressure, one lying north and the other south of the equator. Atmospheric circulation in these areas is characterized by the descending phase of the circulation mechanism known as the Hadley cell. When moist tropical air descends, it becomes hotter and drier; and wherever this pattern of anticyclonic circulation persists, so does aridity. Contingent drought is most severe in areas bordering these zones of permanent drought. Areas prone to contingent drought are found in West Africa, South Africa, Brazil, Australia, and India, and they tend to cluster in latitudes between 15° and 20° North and South. Droughts within these areas result from variations in the pattern of atmospheric circulation known as the WESTERLIES. A southward shift in the westerlies was responsible for the most severe droughts of the 20th century (1968–74, mid-1980s), which affected the West African region called the SAHEL. Because of this shift, the summer monsoon rains upon which the region depends missed the area entirely for years. The resulting droughts claimed hundreds of thousands of lives and killed nearly half the region's livestock.

The effects of contingent drought have been less severe in mid-latitude regions, such as the United States. Droughts in these regions have been found to correspond to the location of disturbances of the JET STREAM that produce atmospheric patterns known as Rossby waves. Droughts of this type were experienced in the western and midwestern United States in the 1890s, 1930s, 1950s, and late 1980s (see DUST BOWL).

Attempts have been made to identify cyclic drought patterns in Asia, Europe, and Africa, based on readings of tree rings, river levels, and lake sediments, as well as on historical records, but they have been largely unsuccessful. Only in North America have researchers been able to detect some correlation between droughts and the cyclic phenomenon of SUNSPOTS. As revealed by tree-ring studies, both droughts and sunspots seem to recur at 20- to 22-year intervals in the western United States (see DENDROCHRONOLOGY).

The effects of drought can be mitigated in a number of ways. Forecasts based on rainfall records can enable measures to be taken that will lessen the effects. Long-term measures include water-conservation projects such as aquifer recharge and the construction of reservoirs. In addition, experiments in techniques of WEATHER MODIFICATION may hold promise for the future.

drowning Drowning is suffocation and death resulting from the lungs being filled with fluids or other substances. The term generally refers to death from submersion in water, but in certain illnesses fluid can fill the lungs because of the ineffective action of the heart. This EDEMA fluid can cause drowning as readily as does water introduced into the lungs from outside. Normally the lungs are filled with air, to which blood is exposed in a multitude of tiny sacs called alveoli. The oxygen-carrying pigment hemoglobin, contained in red blood cells, picks up oxygen from the air and distributes it to the tissues of the body. When water or any other fluid or solid enters the lungs, however, it covers the alveoli and prevents diffusion of oxygen, so that the body tissues are starved and die. Because brain cells are the most active cells in the body, the brain is the organ most vulnerable to the loss of oxygen; thus, one of the first steps in the drowning process is the loss of consciousness. If resuscitation is not applied promptly (see CARDIOPULMONARY RESUSCITATION), the brain will completely lose function. Application of resuscitation 20 to 30 minutes after drowning can result in resumption of heart function without recovery of the brain (see LIFESAVING AND WATER SAFETY).

Under certain circumstances, however, a person can be immersed for 30 minutes or more before rescue and still regain complete consciousness following resuscitation. This is thought to be due to what is called the diver's reflex, in which a sudden decrease in the blood's oxygen content causes the body to slow down metabolism in order to conserve oxygen and to shunt most of the available oxygenated blood to the brain. The diver's reflex is strongest in infants and decreases with maturation, but has been observed in older persons in cold-weather conditions.

See also: FIRST AID.

drug Drugs are substances given to humans or animals for the treatment, prevention, or diagnosis of illness. They are used to relieve pain or other suffering and to improve and control abnormal conditions of the mind and body. A prescription drug must be specifically advised by a physician or a dentist and is often dispensed by a pharmacist. A nonprescription drug does not require professional sanction to obtain or to use. Many drugs, such as narcotics, are subject to abuse (see drug abuse).

Historical Perspective

Humans have used drugs in various forms since prehistoric times. Primitive humans ate plants such as mushrooms, which had physiological effects. The ancient Romans and Greeks practiced a well-developed medicine, using various plants and waters therapeutically. Alcohol, opium, and the derivative of the hyoscyamus plant were used as analgesics and sedatives. The ancient Egyptians used opium for pain, castor oil for worms, and animal blood, viscera, and excreta to treat other ailments. Arab physicians in the 12th century used burned sponge to treat goiter, which probably was a curative because of its iodine content. By the 16th century, physicians were employing colchicum for gout, as is done today.

In 16th-century Europe, Paracelsus led the way in developing a more scientific experimentation with drugs. By 1700, however, European apothecaries were still dispensing *elixir universale*—a mixture of gold, powdered lion's heart, witch hazel, earthworms, dried human brain, and Egyptian onions. In the 18th century, scurvy was effectively treated with citrus fruit, and physicians discovered that digitalis, derived from foxglove, could be used to treat heart disease. Edward Jenner introduced smallpox inoculation in 1796.

By the 19th century, pharmacy was well established. The introduction in 1846 of the anesthetic ether reduced the painful terror of surgery. Chemists began to investigate alkaline substances found in plants, such as atropine and morphine, and they were successful in extracting the active elements from medicinal plants. As a result, it was no longer necessary to depend on naturally occurring substances for drugs; when the active compound had been identified, new, related compounds could be synthesized. The synthesis of salicylic acid in 1860 led to aspirin.

Rober Koch's germ theory of disease, and Louis Pasteur's work led to immunization with attenuated viruses. Pasteur developed vaccines against anthrax and rabies. Diphtheria antitoxin was produced by Emil Behring. The search began for drugs that would destroy disease-causing organisms.

In 1909, Paul Ehrlich produced arsphenamine, the so-called magic bullet against syphilis. For 25 years thereafter no new antimicrobial drugs were found, but many other drugs still in use today were produced—for example, adrenaline, ephedrine, insulin, thyroxin, and liver extract. The next major advance occurred in 1935, when Gerhard Domagk observed the antibacterial action of the sulfonamides. In 1939, Howard W. Florey and his associates amplified Sir Alexander Fleming's discovery of penicillin in 1929. The antibiotic era had begun.

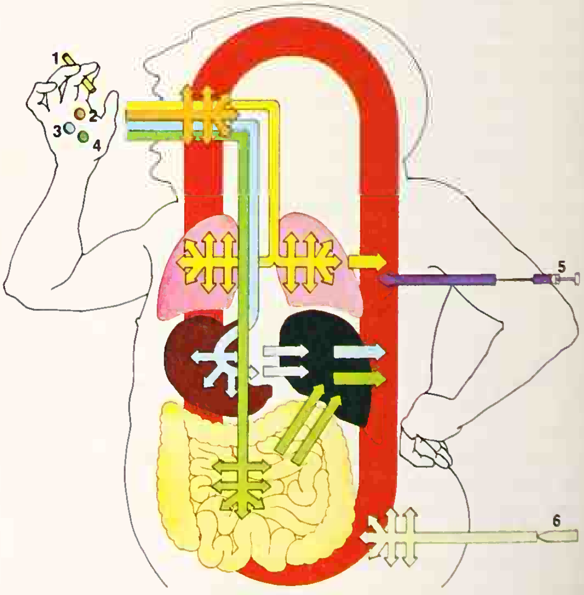
During the 1940s and '50s, many drugs were developed to treat diseases that had previously been untreatable. Anticancer drugs and steroids came into use in the late 1940s. Treatment of mental illness was greatly advanced in the 1950s with the use of chlorpromazine to treat schizophrenia and the introduction of antidepressants and tranquilizers.

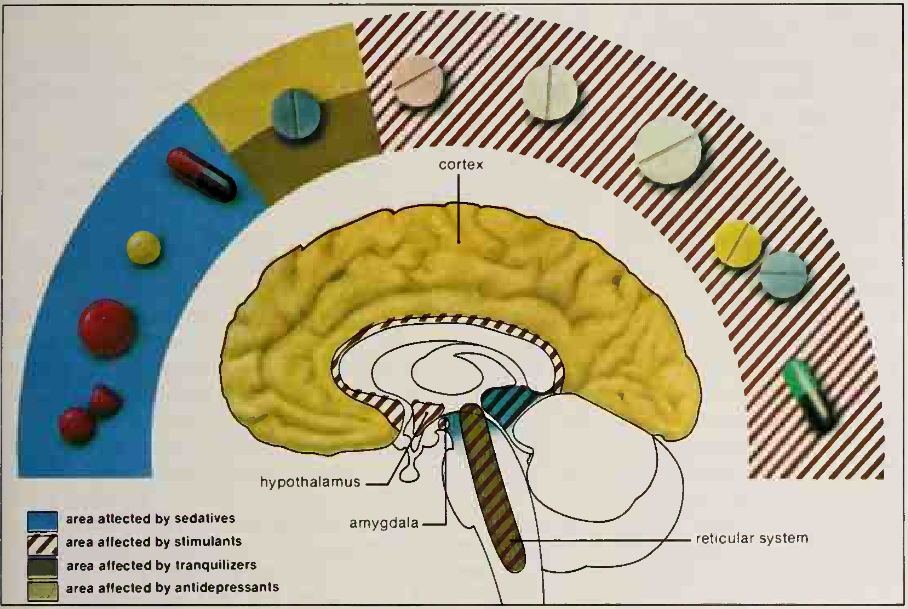
Today virtually no disease exists for which some drug cannot be given, either to cure the disease or to alleviate its symptoms. Drug research on the frontiers of medicine has led back to the body itself. Investigation of prostaglandins and endorphins, substances the body produces that may have wide therapeutic application, has begun. It is now common practice to use drugs to suppress normal physiological states, as is done with oral contraceptives and psychedelic drugs.

Administration of Drugs

Skin. A drug may be applied directly to the skin in the form of a powder, cream, lotion, ointment, or solution. Some of the drug may be absorbed by the body. In transdermal medication, drugs seep slowly into the body from a drug-containing patch placed on the skin. Drugs may also be injected into the skin.

Gaseous drugs, such as anesthetics, nicotine, and opium, are absorbed through the lungs by inhalation (1). *Such drugs as steroids, which are easily inactivated by digestion or liver metabolism, can be absorbed in the mouth* (2). *Swallowed medicines may be absorbed by the stomach* (3) *or, for those drugs which are destroyed by stomach acid, given as capsules that dissolve in the small intestine* (4). *In both cases the drugs pass through the liver before reaching the bloodstream. Injection* (5) *and skin-applied ointments and patches are the most direct route into the bloodstream; the drug does not pass through the liver first. Rectal administration* (6) *also avoids inactivation by the liver.*




cortex
hypothalamus
amygdala
reticular system
🟦 area affected by sedatives
▨ area affected by stimulants
■ area affected by tranquilizers
■ area affected by antidepressants

Antidepressants are used to treat depression and certain phobic states. They act on emotional centers in the midbrain and thus can elevate the mood of depressed patients. Sedatives such as barbiturates produce drowsiness and sleep and inhibit convulsions. They affect the cerebral cortex and the reticular activating system, which plays a role in the arousal-sleep cycle, to reduce alertness and conscious thoughts. Tranquilizers are used mainly to treat anxiety. They influence the reticular system and the limbic system, a collection of regions associated with emotional aspects of behavior that are in the central area of the brain. The limbic system includes the hypothalamus, which responds to emotional changes, and most of the amygdala, which responds to fear and anger. These are sites of action for stimulants as well.

Injections. Injections cause drugs to enter body tissues or fluids directly. They may be given under the skin (subcutaneously), but most are given into muscle (intramuscularly). With the latter method, absorption into the circulation is rapid, since most muscles contain many blood vessels. ("Depot" injections, however, are sometimes used, in which medication is slowly released over days or weeks.) Injections may be given directly into veins or, rarely, into arteries; in seconds the drug is transported throughout the circulatory system. Injections are occasionally placed into bone marrow, the abdominal cavity, or the spinal column.

Intestinal Tract. Some drugs enter the circulation by absorption through the mucous membranes of the mouth. A few drugs pass from the mouth to the stomach or the small intestine before being absorbed. A drug may also be administered through the other end of the intestinal tract, the rectum.

Tissue Linings. Absorption of some drugs, such as NICOTINE, may begin in the nasal passages, which are lined with mucous membrane. The lungs have large areas of tissue into which gases may be absorbed. In fact a drug may enter the circulation wherever an absorbent surface is available, even through the vagina, the urethra, or the lining of the eyes.

Bioavailability. Unless a drug is specifically intended to act directly on the blood, its initial absorption into the circulatory system is only the beginning of a long process. Some of the drug may be broken down by liver enzymes. Some may be concentrated in tissues where it is not needed. A significant amount may be quickly excreted. Processes in the blood itself affect drugs. Thus, only a small amount of an ingested drug actually exerts the desired therapeutic effect. Bioavailability is related to the percentage of a drug dose that is actually biologically active.

Metabolism of Drugs

Drug metabolism refers to the physical and chemical processes to which drugs are subjected in the body. Drugs may be broken down, joined to other compounds, combined with oxygen, have specific atoms replaced by others, or undergo various other changes. Some must be metabolized to different forms before becoming biologically active.

Most drug metabolism occurs in the liver, but some occurs in the kidneys. All tissues, however, are probably capable of metabolic activity. Metabolism is done primarily by enzymes—gene-produced organic compounds of protein that catalyze specific chemical reactions. Most enzymes are located inside cells, in structures collectively called the endoplasmic reticulum. Drug metabolism in the liver is performed mainly by enzymes called hepatic microsomal enzymes.

The enzyme activity of one drug may be influenced by the presence of other drugs. A drug may stimulate enzyme activity, causing increased metabolism of another drug; this process, called enzyme induction, is a principal mechanism of drug interactions. Some drugs exert their therapeutic action by inhibiting specific enzymes, such as monoamine oxidase.

Dosage. People vary in size, weight, activity of liver enzymes, and ability to absorb, bind, excrete, and so on. Drugs are metabolized differently at different ages. Both an infant with an immature liver and a person whose metabolic machinery is aging take longer to metabolize a drug than does a young adult. Thus, the same dosage of drug may have different effects on different people. This is why drug dosage and administration must be carefully monitored.

Half-Life and Withdrawal. The half-life of a drug is the time it takes for one-half of a standard dose to be eliminated. This varies from person to person, depending on their unique metabolic characteristics. A general range is known, however. VALIUM (diazepam), a popular tranquilizer, has a half-life of about 24 hours. This means that if a dose of 5 milligrams (mg) is taken, about 2.5 mg are still in the body 24 hours later. When a patient continues to take 5 mg each day, Valium continues to build up in the body for about 2 weeks. At that point, the body's ability to clear the drug from the system balances the daily intake, and the drug reaches a steady state. If the patient then stops taking the drug, the level falls fairly quickly and the patient may experience withdrawal symptoms.

Drugs and the Nervous System

The peripheral nervous system runs to all parts of the body. Some nerves control muscles that are under conscious control. Others go to structures not under voluntary control, forming a system called the autonomic nervous system. Nerve cells function by stimulating receptors in the structures to which they connect. The point at which the stimulation takes place is called the synapse. Nerve cells release a tiny amount of a chemical substance, the neurotransmitter, which crosses a space, the synaptic cleft, to reach the receptors.

Neurotransmitters may be influenced by drug action, especially by drugs used in treating emotional illness. One of the most important neurotransmitters is acetylcholine, which is the main neurotransmitter of a part of the autonomic nervous system called the parasympathetic system. Stimulation of the parasympathetic nervous system causes salivation, pupil contraction, slowing of the heart, speeding of the intestines, and other effects. After acetylcholine is released, it is destroyed by the enzyme acetylcholinesterase.

Many drugs, called anticholinergic drugs, partially block the action of acetylcholine. They cause the pupils to dilate, the salivary glands to reduce secretion, the heart to speed up, and the digestive system to slow down. They may also partially paralyze the urinary bladder. Sometimes an anticholinergic drug is given to slow down the intestinal tract in cases of diarrhea. The classic anticholinergic drug is atropine.

Another major neurotransmitter is noradrenaline, which acts in the sympathetic portion of the autonomic nervous system, or adrenergic system. Generally its effects are in contrast to those of acetylcholine. Sympathetic stimulation causes dilation of the pupils, speeding of the heart, slowing of the gut, and other effects. Drugs are given to block actions of noradrenaline in cases in which the heart is overly sensitive to sympathetic stimulation.

Usually only a small fraction of the drug dose reaches the BRAIN. Some parts of the brain are more sensitive to drug action than others. For example, the cerebellum, which controls balance and movement coordination, is sensitive to alcohol. Valium mainly affects the midbrain, which controls emotional expression, hunger, aggression, and some endocrine functions. Other drugs affect structures that influence voluntary movement. For example, muscle-relaxant drugs block reflexes in the spinal cord, thus reducing impulses to the muscles and reducing muscle tension or spasm.

Drug Interactions

Drug interactions are defined as drug actions that increase or reduce the effectiveness or toxicity of another drug. This may occur in several ways:

1. Additive effects. Alcohol increases the effect of barbiturates and other sedatives, sometimes to a dangerous degree.
2. Interference with absorption. ANTACIDS (or milk) may reduce intestinal absorption of tetracycline, an antibiotic.
3. Displacement. One drug may displace another drug from plasma proteins, making the displaced drug biologically more active.
4. Chemical combinations. Drugs such as calcium and fluoride may combine chemically, rendering both inert.
5. Enzyme induction. Some drugs—for example, BARBITURATES—increase the metabolic activity of liver enzymes that metabolize other drugs. Smoking also causes enzyme induction.
6. Metabolic inhibition. Some drugs act to inhibit specific drug-metabolizing enzymes, thus permitting these drugs to act more powerfully for longer periods.
7. Receptor interference. One drug may displace or block another at the receptor level.
8. Increase or decrease of excretion. Some drugs share excretory pathways in the kidneys. One drug may thus keep another in circulation longer by reducing its excretion.

Drug Side Effects

A side effect may be defined as any result of a drug's actions other than that for which the drug is therapeutically intended. The most common side effects of which patients complain are those involving the nervous system and the intestinal tract. Many drugs produce feelings of drowsiness, fatigue, and nausea by direct action on the brain. Anticholinergic drugs, by blocking acetylcholine in the autonomic nervous system, produce blurred vision, dry mouth, rapid heartbeat, constipation, and sometimes impotence and reduced ability to urinate. Other drugs, such as aspirin, have an irritating effect on the stomach, causing burning pain, nausea, vomiting, and diarrhea.

Less frequently, but more seriously, drugs may lower the blood pressure to the point where dizziness, even fainting, occurs. Drugs may disrupt the endocrine system, causing, for example, disturbance in the menstrual cycle. Sometimes patients believe they are allergic to a drug, when in fact they are experiencing a common side effect.

Allergy

A genuine ALLERGY may cause rash; hives; itching; wheezing or other breathing difficulty; diarrhea and vomiting; swelling of the hands, feet, and face; fainting; shock; or other serious physical disturbance.

Allergies to drugs occur in the same way as do allergies to any other foreign substance. For some reason the drug becomes an ANTIGEN, a substance that stimulates the formation of protein compounds called antibodies. This is a vitally important defense mechanism when infection occurs. In the allergic state, however, the antigen-antibody causes undesirable physiological actions.

Allergies take time to develop, as the body cannot instantaneously form antibodies. Consequently, it is impossible to be allergic to a drug the first time it is given, unless one is already allergic to a similar drug. Such an allergy is caused by a process called cross-sensitization. (Antigens and antibodies combine only with each other or with almost identical compounds.)

Drug allergies rarely occur, however, and both physician and patient should be aware of the patient's allergies and the difference between the true allergies and side effects.

Drug Toxicity

Drug toxicity may occur immediately or after the drug has been taken for a long period. Some forms of toxicity are simply extensions of desired effects—for example, excessive drowsiness from a tranquilizer. Most incidents of drug toxicity result from excessive dosage and can be treated by stopping the medication temporarily or by lowering the dose.

Types of Toxicity. Because the liver is exposed to drugs in high concentration, it is vulnerable to the direct effects of drugs. This may produce chemical hepatitis. The kidney, too, may become drug-saturated in its work as an excretory organ.

Drugs may cause tragic malformations of unborn infants. This form of toxicity is called teratogenicity. For this reason, drugs are avoided whenever possible during pregnancy, especially in the first three months. The long-term use of drugs by women of child-bearing age is not recommended.

Tranquilizers, sedatives, and other similar drugs may cause alteration of feelings and moods, decreased motivation, memory impairment, poor judgment, and reduced motor coordination. The use of opiates, barbiturates, AMPHETAMINES, cocaine, MARIJUANA, and other sedatives or HYPNOTIC DRUGS may result in a state of physical and psychological craving. Withdrawal states of varying degrees occur with some, but not all, addictive drugs.

Risk versus Benefit. When prescribing a drug, the physician usually considers possible toxicity, weighing this risk against the potential benefit to be received from the drug and the severity of the disease. For example, anticancer drugs are usually extremely toxic, since they work by disrupting cellular metabolism and thus affect normal tissue as well as the cancer. The alternative, however, is usually a speedy death.

Accusations have been made that physicians regularly misprescribe, and in some cases this is probably true. Such errors may stem from inadequate training, fatigue, economic motives, laziness, or human error, such as inaccurate examination or diagnosis. Sometimes a patient may demand a shot when none is needed, and the doctor may comply.

Training in PHARMACOLOGY is an important part of medical school, and it is imperative for doctors to continue to study drugs throughout their careers in order to remain competent. Other factors reducing drug dangers include quality research and evaluation and well-regulated production and dispensation of drugs.

Drug Development and Regulation

It is only in the last century that techniques have existed for the adequate evaluation and regulation of drugs. In preceding centuries, many ineffective remedies were used by physicians who honestly believed in them.

Several factors contribute to the continued use of drugs lacking medicinal value, one of the most important being the placebo effect. A placebo is a physiologically inert medication that still may exert an effect due to the psychological factor of suggestability. If the patients expect to feel better, or are told they will by an important authority figure (doctor or mother, for example), their condition will probably improve.

Sometimes a patient may improve because of the natural course of the disease—for example, wounds heal by themselves, and natural body defenses eliminate most infections. The application of a drug may not actually affect the disease process, though it may seem to. Inaccurate observation may also be made by the physician or the patient. Good drug research must include an experimental design that takes into account a variable disease course, patient suggestability or bias, observer bias, and placebo effect. These are usually offset by the use of control groups and the double blind.

A control group is a group of animal or human subjects who have the same disease as the patients receiving treatment, and who are kept under identical conditions but do not receive the treatment. If the treatment is effective, the disease will be cured or its term shortened in the treatment group but not in the control group.

The double blind means that neither the patient nor the observing doctor knows what treatment is being given. This is accomplished by making up a preparation that is identical outwardly to the drug being investigated but is really a placebo. The placebo is given to a group of patients chosen at random who do not know, nor do the treating physicians know, that they are receiving placebos. Thus, the observations of those directly involved are not influenced by a conscious or unconscious wish to prove the efficacy of the drug.

U.S. Food and Drug Administration

The U.S. Food and Drug Administration (FDA) is charged with ensuring the safety and efficacy of drugs. Its bureaucratic procedures, however, have prevented Americans from having access to some useful drugs that are available in other countries. For example, the drug lithium carbonate, discovered in 1949 to be of value in manic-depressive psychosis, a tragically disabling mental illness, was used in Australia and Europe for many years before receiving FDA approval in 1969. On the other hand, FDA caution saved the American public from the tragedy of THALIDOMIDE.

The PHARMACEUTICAL INDUSTRY markets drugs and conducts drug research. Many important advances in treatment have come from these commercial institutions. Squibb did research on ether and chloroform and improved their safety in surgery. Parke-Davis developed epinephrine. Upjohn developed adrenal cortical hormones, revolutionizing treatment of arthritis and other steroid-sensitive diseases. Schering and Ciba devised artificial sex hormones. Abbott pioneered intravenous anesthetics. Many other contributions, such as GENETIC ENGINEERING techniques, have been made by this industry as well.

See also: HALLUCINOGENS; IMMUNITY (biology).

drug abuse The term *drug abuse* most often refers to the use of a drug with such frequency that it causes physical or mental harm to the user or impairs social functioning. Before 1973 the term had referred to the use of any drug prohibited by law, regardless of whether it was harmful or not. This meant that any use of MARIJUANA, even if it occurred only rarely, would constitute abuse, while the same level of ALCOHOL CONSUMPTION would not.

The term *drug* is associated both with substances that may be purchased legally with prescription for medical use, such as penicillin, which is almost never abused, and VALIUM, which is frequently abused, and with illegal substances, such as angel dust, which are taken for the purpose of getting high, or intoxicated, but have no medical use. Other substances that may be purchased legally without prescription and are commonly abused include alcohol (see ALCOHOLISM) and NICOTINE, contained in tobacco. In addition, in recent years, chemists working in illegal, clandestine laboratories have developed new chemicals, called "designer drugs," that have been used for the purpose of getting high. All these substances are psychoactive. Such substances—legal and illegal—influence or alter the workings of the mind; they affect moods, emotions, feelings, and thinking processes. For a general description of drug types, including an outline of their historical development and use, and their effects on the human body, see the article DRUG.

Drug Dependence. Drug abuse must be distinguished from drug dependence. Drug dependence, formerly called drug addiction, is defined by three basic characteristics: (1) users continue to take the drug over an extended period; (2) users find it difficult or impossible to stop using the drug, often resorting to extraordinary or harmful measures to obtain it; and (3) users experience painful physical or mental distress, called the withdrawal syndrome, if they stop taking their drug—if their supply is cut off, or if they are forced to quit for any reason. Drug dependence may lead to drug abuse, especially of illegal drugs.

Psychoactive, or mind-altering, substances are found the world over. The coca plant grows in the Andes of South America and contains 1–2 percent COCAINE. The marijuana plant, *Cannabis sativa*, contains a group of chemicals called tetrahydrocannabinol, or THC, and grows wild in most countries, including the United States. The opium poppy is the source for OPIUM, MORPHINE, HEROIN, and CODEINE. It grows in the Middle East and the Far East. HALLUCINOGENS (such as LSD), the AMPHETAMINES (speed), and SEDATIVES, such as methaqualone (Quaalude) and BARBITURATES, are manufactured in clandestine laboratories worldwide. As a result, psychoactive drugs are used for the purpose of intoxication almost everywhere.

Classification of Psychoactive Drugs. Pharmacologists classify psychoactive drugs according to what they do to those who take them. Drugs that speed up signals passing through the nervous system and produce alertness and arousal and, in higher doses, excitability, and inhibit fatigue and sleep, are called STIMULANTS. They include the amphetamines, cocaine, caffeine, and nicotine. Drugs that slow down or depress signals passing through the central nervous system and produce relaxation, a lowering of anxiety, and, at higher doses, drowsiness and sleep are called depressants. They include sedatives, such as barbiturates, methaqualone, and alcohol, and TRANQUILIZERS, such as Valium. Narcotics, one distinct kind of depressants, dull the mind's perception of pain and are used medicinally as painkillers, or analgesics. They include heroin, morphine, opium, and codeine. In addition to their painkilling properties, these depressants also produce a strong high and are intensely dependency producing. Some drugs cannot be placed neatly in this stimulant-depressant spectrum. Hallucinogens, including LSD, mescaline, and psilocybin, produce unusual mental states, such as psychedelic visions. Marijuana is generally regarded as a drug type unto itself.

History of Drug Abuse in the United States. During the 19th century there were virtually no controls on the importation, sale, purchase, possession, or use of psychoactive drugs. Dangerous substances such as opium, cocaine, and morphine were basic ingredients in patent medicines that could be purchased by anyone, without a prescription. As a result of their ready availability, many individuals became addicted to the narcotics contained in them. In fact, in 1900 there were more narcotics addicts, proportionate to the population, than there are today. Most users who became addicts were medical addicts. Very few abusers took drugs for "recreational" purposes. In 1914, in an effort to curb the indiscriminate use of narcotics, the federal government passed the Harrison Act, making it illegal to obtain a narcotic drug without prescription. During the 1920s the Supreme Court ruled that maintaining addicts on narcotic drugs, even by prescription, was in violation of the Harrison Act. Approximately 30,000 physicians were arrested during this period for dispensing narcotics, and some 3,000 actually served prison sentences. Consequently, U.S. doctors all but abandoned the treatment of addicts for nearly half a century.

The use of narcotic drugs dropped sharply in the United States between the 1920s, when there were some half a million addicts, and 1945, when the addict population was roughly 40,000 to 50,000. The recreational use of other drugs, such as marijuana, cocaine, stimulants, hallucinogens, and sedatives, also remained at extremely low levels.

In the 1960s, increased tolerance for a wide range of unconventional behavior was accompanied by the widening use of illegal drugs. A vigorous drug subculture proved a powerful force in recruiting young people into the use of psychoactive substances. Although media attention to drugs and to drug use declined between the late 1960s and late 1970s, the actual use of drugs strongly increased during this period. The 1980s, however, witnessed a considerable drop in the use of most drug types.

Cocaine and its derivative, crack, are major exceptions. Crack, the smokable form of cocaine, first appeared in the mid-1980s and rapidly became the most widely abused illicit drug in the United States. New forms of older drugs such as the "Ecstasy" and "Ice" methamphetamines also proved highly addictive, with sometimes devastating side effects.

Patterns of Drug Abuse. Some 70 million Americans aged 12 and over have tried at least one prohibited drug for the purpose of getting intoxicated, or "high." The illegal drug trade represents an enormous economic enterprise. About 60 percent of the illegal drugs sold worldwide end up in the United States.

By far the most commonly used illegal drug is marijuana, which figures in roughly half of all episodes of illegal drug use. Studies sponsored by the federal government show a significant drop-off in marijuana use, however, and a substantial decline in daily or near-daily use throughout the 1980s. Cocaine is the second most commonly used drug in the United States, and heroin one of the least-often used, though its use has produced half a million addicts.

Most people who have taken illegal drugs have done so on an experimental, short-term basis. Of all illegal drugs, marijuana is the one users are most likely to stick with. The same pattern holds for cocaine. Discontinuation rates are very high, however, for drugs such as methaqualone, sedatives, barbiturates, heroin, and LSD. The typical regular marijuana smoker is a casual, once-in-a-while user, though a sizable minority uses the drug frequently. A pattern of episodic, regular use characterizes nearly all drug use for the purpose of recreation.

Drug Law Enforcement. In 1970 the U.S. Congress passed the Comprehensive Drug Abuse Prevention and Control Act. Most of the states followed suit by basing their state legislation on the federal model. The Control Act distinguishes among several categories of drugs based on their abuse potential and their medical utility. Drugs that have a high potential for abuse and no currently accepted medical use, including heroin, LSD and the other hallucinogens, and marijuana, may be used legally only in a federally approved scientific research experiment. These drugs are tightly controlled by both federal and state laws. Such drugs as morphine, cocaine, methaqualone, the amphetamines, and short-acting barbiturates are also regarded as having great abuse potential, even though they do have accepted use in medicine. Rigid prescription procedures are employed to maintain extremely tight controls over their use. Such medically prescribed drugs as long-acting barbiturates and nonnarcotic painkillers, as well as tranquilizers, are considered to have a lesser abuse potential (although they may lead to low physical dependence or high psychological dependence) and therefore have more relaxed controls. There was a remarkable drop in the number of prescriptions written for psychoactive drugs in the decade 1970–80.

The picture for illegal street drugs is far more complicated. The illicit use of barbiturates and other sedatives, methaqualone, and tranquilizers had dropped significantly by the mid-1980s, but the illegal use of stimulants has continued to be significant, especially in high schools. The demand for drugs for illegal purposes remains great in spite of law-enforcement efforts. In the 1970s the number of arrests on marijuana charges in the United States more than doubled, but did not seem to deter marijuana use. Likewise, the number of arrests on the charge of narcotics possession and sale increased greatly in the 1980s. While the use of heroin held its own during this period, the use of cocaine exploded. The actual impact that law enforcement has on the use of illegal drugs is uncertain. Nonetheless, in the face of mounting public concern, Congress in 1986 passed strong new drug laws and enforcement measures, along with treatment and education programs.

Drug Testing in the Workplace. Drinking on the job is a social and economic problem with a long history. The use of illegal drugs in the workplace emerged as a major issue in the 1980s. Estimates of employee drug use vary greatly, ranging from 10 percent to 25 percent. The safe performance of some occupations—among them, airline pilot, air traffic controller, truck driver, and physician—can be compromised by drug use. In 1986, President Reagan's Commission on Organized Crime recommended that all U.S. companies routinely test their employees for drug use.

The question of drug testing has become a major issue in American politics. Conservatives contend that the danger of drugs on the job is so great that everyone should be tested. Workers caught with traces of drugs in their bloodstream or urine should be fired or treated. The U.S. Constitution, they say, does not guarantee a pilot the right to risk the lives of hundreds of passengers.

Liberals insist that the risk to individual rights, particularly the freedom from unreasonable search guaranteed by the 4th Amendment, posed by indiscriminate and random testing makes the program unacceptable. Employers have no right, they say, to monitor the bodies of workers for the presence of drugs. Some drugs leave traces in the bloodstream for weeks after use. Moreover, the tests are not completely reliable.

Some companies and government agencies have instituted drug-testing programs for their employees. Drug testing is common in the armed forces and is often cited as a major factor in reducing the use of drugs among military personnel. Nonetheless, the practice of testing will probably never become universal because with most jobs an intoxicated worker poses no hazard and because the cost of large-scale testing could be prohibitive. Although the U.S. Supreme Court ruled (1989) that the federal government could require drug testing of both private and government employees whose work involved public safety or law enforcement, the question of the constitutionality of the random testing of most workers remains.

Treatment. From the 1920s until the 1960s, treatment of drug abuse in the United States was practically nonexistent. Drug abusers and sellers were simply arrested and imprisoned. Two treatment programs developed during the 1960s—methadone maintenance and the therapeutic community—were aimed mainly at narcotic addiction.

METHADONE, a synthetic narcotic, is used to combat narcotic addiction. Methadone is also addictive. The purpose of the program is to administer methadone to heroin addicts in a controlled setting, such as a hospital or a clinic. The drug is taken orally, which prevents the addict from getting high. In addition, methadone blocks the action of narcotic drugs so that addicts cannot become high even if they inject heroin. Thus, although former heroin users will still be addicted to methadone, they can live a normal life, since their supply of methadone is steady and secure. Because the program is inexpensive to administer, methadone is a popular form of treatment.

By contrast, therapeutic communities (TCs), such as Daytop Village in New York and Walden House in San Francisco, advocate a completely drug- and alcohol-free existence. Addicts in therapeutic communities are live-in residents of the program, and most of the administrators are ex-addicts. TCs attempt to resocialize the addict by inculcating a value system that emphasizes honesty and responsibility, and toward this end, maintain the strictest discipline. They are expensive to administer.

Less structured self-help programs, modeled on that of Alcoholics Anonymous, are offered at no cost by such organizations as Narcotics Anonymous and Cocaine Anonymous.

drug trafficking Drug trafficking refers to the illegal manufacture or sale of controlled substances. These range from drugs having a high potential for DRUG ABUSE and no generally accepted medical use (heroin, for example) to those having an accepted medical use but that can lead to dependence, like pentobarbital.

HEROIN is a chemical derivative of opium, juice of the poppy that is cultivated for profit in the Middle East, Asia, and Mexico. In the Golden Triangle of Southeast Asia, which includes parts of Laos, Thailand, and Burma, the Shan United Army maintains an impressive military presence supported by trafficking in opium. Other major groups dealing in drugs within this area are remnants of the defeated Chinese Nationalist Army and the Burmese Communist party. Opium is also cultivated by Pathan tribesmen in Afghanistan and by "crime families" in Mexico.

The poppies produce opium gum, which is converted into base-morphine and finally heroin, which is smuggled into Europe and the United States at a purity level of more than 90%. Smuggling is accomplished by couriers for a variety of international ORGANIZED CRIME groups—Chinese triads, Italian Mafia, and Camorra groups—and by independents. After importation the heroin is diluted to a purity level of about 5%. Street sale to addicts is carried on by numerous groups, particularly street gangs in urban areas.

COCAINE is derived from the coca plant, grown in such Latin American countries as Bolivia (where it is legal), Brazil, Colombia, Ecuador, and Peru. Usually grown in remote areas where government control is tenuous, coca is often a very significant local cash crop, and attempts to suppress trafficking fans antigovernment sentiment in countries beset by revolutionary groups. This, combined with government inefficiency and corruption, makes coca growing and cocaine trafficking difficult to eradicate. Much of the cocaine entering the United States arrives via Colombia, where sophisticated, powerful, and violent criminal organizations like the "Medellín cartel" maintain elaborate drug networks.

Efforts to contain this extraordinarily profitable drug trafficking have proven ineffective, thwarted by corruption (even at very high levels) and the law of "supply and demand." Drug trafficking has complicated U.S. foreign policy in Latin America and has also provided alarmed U.S. citizens with a major domestic political issue.

druids [droo'-idz] Among the ancient CELTS, the druids were a class of priests and learned men. They formed an important part of every Celtic community in Ireland, Britain, and Gaul, and their leaders often rivaled kings and chiefs in prestige, if not power. They seem to have served as judges as well as priests, and their counsel was eagerly sought by all classes of society.

Unfortunately, most knowledge about the druids is derived from Roman sources, for the druids themselves disdained writing and preferred to pass along their tradition orally. They were responsible for educating the sons of chiefs and generally served as the guardians of the sacred tradition.

It is known that oak trees and mistletoe played an important part in druidic rituals (the word *druid* itself may be related to *daur*, the Celtic word for oak tree), as did human sacrifice. Sacrificial victims were sometimes burned in large wicker baskets in order to ensure military success or the health of the chief. These acts, as well as the druids' fierce resistance to the spread of Latin culture, led to their suppression by Roman authorities in Britain and Gaul; in Ireland, which never came under Roman rule, druidism survived until AD *c.*500. Perhaps for this reason pre-Christian Irish mythology is better preserved than that of other ancient Celtic groups.

Earlier scholars frequently associated the druids with STONEHENGE, but it is now known that Stonehenge was completed well over a millennium before the first Celts reached the British Isles (between 550–450 BC).

drum (fish) A drum, or croaker, is any bottom-feeding fish of the family Sciaenidae, order Perciformes. The approximately 200 species of this family are characterized by the drumming or croaking sounds they make with their elaborate swim bladders; some species also produce sounds by means of large pharyngeal teeth. The fish inhabit all tropical and most temperate oceans, feeding mainly on invertebrates. The heaviest, the black drum, *Pogonias cromis*, can weigh more than 55 kg (125 lb), but most species are small. Several of them, such as the Atlantic croaker, *Micropogon undulatus*, and the spot, *Leiostomus xanthurus*, are important food and game fish. The only freshwater species, *Aplodinotus grunniens*, is common in the eastern United States. Other common names for these fish include corvina, kingfish, WEAKFISH, and white sea bass.

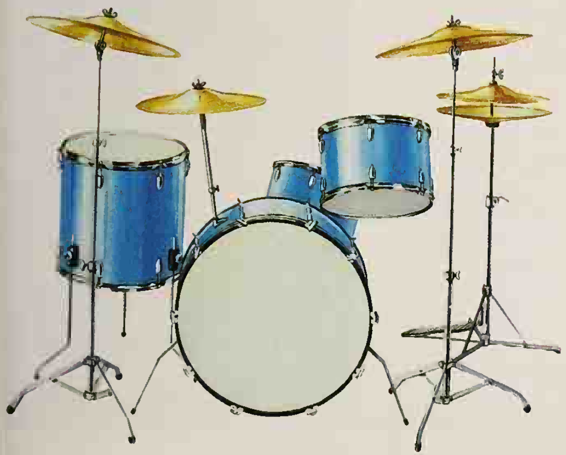
drum (musical instrument) Drums are among the oldest musical instruments, found throughout the world and in a great variety of shapes and sizes. A drum normally consists of a skin or other membrane, called a head, which is stretched over an enclosed space or over one or both ends of a hollow vessel. Exceptions include the African slit drum, made from a hollowed-out tree trunk, and the Caribbean steel drum, made from a metal barrel. Drums are usually played by the hands or by one or two sticks. In some non-Western cultures drums have a symbolic function and are often used in religious ceremonies. They are sometimes used in sending signals. The talking drums of Africa can imitate the inflections and pitch variations of a spoken language and are used for communicating over great distances.

Many drums used in Western societies are of African, Arabic, or Turkish origin. The KETTLEDRUM was introduced into Europe during the Crusades. The European tabor, derived from an African instrument and sometimes called a tambour, was a small drum played with the right hand, while the left hand fingered a 3-hole flute. Across its center, the tabor often held a snare, which produced a strong vibration and sustained the sound between beats.

The modern symphony orchestra employs a variety of drums. Kettledrums are the most common; the bass drum, tenor drum, and SNARE DRUM, or side drum, are also sometimes used, along with tambourines and bongo drums on occasion. Among these, only the kettledrums produce sounds of definite pitch, which is adjustable. The tenor drum is a large deep drum with two heads that is played with wooden sticks. The larger bass drum, also with two heads, stands upright on its side and is struck with felt-padded sticks. Bongo drums are small single-headed drums struck with the hands and usually played in sets of two or three. The tambourine is a shallow single-headed drum with metal jingles inserted into the frame.

Drums are also used in large numbers in military and marching bands. Traps, an assortment of drums and other percussion devices played by a single performer, have been a standard feature of dance and jazz bands since the early part of the 20th century.

This set of modern drums includes a tenor drum, snare drum, bass drum, and both single and hi-hat cymbals. The bass drum and hi-hat cymbals are sounded through the action of foot pedals, leaving the hands free to strike the other instruments with sticks or brushes.



drumlin [druhm'-lin] A drumlin (from the Gaelic *druim,* meaning "mound") is an elongated hill of glacial DRIFT, with a shape similar to the inverted bowl of a spoon. Occurring in swarms of several thousand, drumlins were probably formed by glacier ice shearing over other ice made stationary by an overload of debris (see GLACIER AND GLACIATION). The long axis of the drumlin thus lies in the direction of the ice movement, with the highest point at the "upstream" end.

Drury, Allen [droo'-ree] Allen Drury, b. Sept. 2, 1918, is best known for his novel *Advise and Consent* (1959; film, 1962), about the underside of congressional politics. He received the Pulitzer Prize for fiction in 1960. A journalist as well as a novelist, Drury writes fiction that is based on his intimate knowledge of the workings of American government. Among his other works are *The Hill of Summer* (1981) and *Pentagon* (1986).

Drury Lane Theatre The Drury Lane, London's most famous theater, is the direct descendant of the Theatre Royal, built on the site by Thomas Killigrew in 1662 as the first permanent playhouse of the Restoration. Partially destroyed by fire in 1672, the Theatre Royal was replaced by a larger structure, the Drury Lane, thought to be designed by Christopher WREN; it was in this theater that John Dryden's plays were produced. From 1710 to 1734 the theater was managed by a triumvirate that included Colley CIBBER; in 1747 the Drury Lane came under the management of actor David GARRICK, who revolutionized staging and acting there. He was succeeded in 1777 by Richard Brinsley SHERIDAN, who inaugurated his managerial reign by the premiere of one of his own plays, *The School for Scandal.* The building was rebuilt (1791–94) and enlarged by Henry Holland, only to burn down in 1808. Although Edmund Kean debuted (see KEAN family) at the Drury Lane in 1814, the theater declined during the 19th century. Today it serves primarily as the home of musical comedy.

Drusus (family) [droo'-suhs] The Roman patrician family of Drusus had several distinguished members. **Marcus Livius Drusus,** d. 109 BC, served (122) as tribune with Gaius Sempronius GRACCHUS, whom he later led the opposition against and disgraced. He became (112) consul and fought successfully in Macedonia in 110. His son **Marcus Livius Drusus**, d. 91 BC, also became (91) tribune and proposed large-scale popular reforms, including granting citizenship to Rome's Italian allies. Because of conservative opposition his legislation was annulled, and he was murdered. The result was the Social War (91–87) between Rome and its allies. Livia Drusilla, a member of the family by adoption, was the mother not only of Emperor Tiberius but of **Nero Claudius Drusus Germanicus** (38–9 BC). Highly regarded by his stepfather Augustus, he commanded (13–12) in Gaul and then undertook four largely successful campaigns (12–9) in Germany, where he died. He was the father of Germanicus Caesar and Claudius I.

Druzes The Druzes (or Druses) are a closely knit religious community living mostly in Syria and Lebanon. The Druze religion, an offshoot of the Ismailis, began in the reign (996–1021) of the Fatimid caliph al-Hakim. In 1017, al-Hakim was publicly declared to be the final incarnation of God; this declaration historically founded the religion whose name derives from al-Hakim's first missionary, al-Darazi (d. 1019). The Druzes' first imam (religious leader), however, was Hamza ibn Ali, al-Darazi's rival. After al-Hakim disappeared in 1021, Hamza developed the doctrines of the faith, which included the belief that al-Hakim would return on Judgment Day.

For the Druzes, belief in Hakim as the final manifestation, the ultimate *maqam* (Arabic, "location") or incarnation of God, invalidates all other religions. The Druzes also believe in God's gradual manifestation in five cosmic emanations: Universal Intelligence, Universal Soul, the Word, the Right Wing, and the Left Wing (see emanationism). These emanations find historical embodiment in their five highest-ranking disciples, Hamza being the embodiment of the Universal Intelligence.

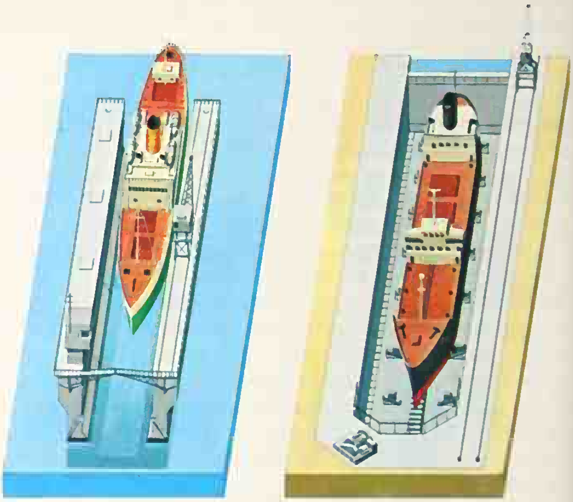
The most authoritative Druze religious text is the *Kitab al-hikma* (Book of Wisdom), a collection of 111 letters, some of them written by al-Hakim and Hamza. The community is divided into two groups: the *uqqual* and the *juhhal*. The *uqqual* are those initiated into the teachings of the *hikma* (religious doctrine); the *juhhal*, comprising the great majority of the population, are unfamiliar with these tenets.

The Druzes, with their strong sense of identity, allow no conversion or intermarriage. For such an isolated community, they have played and continue to play a surprisingly important role in the political history of Syria and Lebanon.

In Lebanon, where they constitute about 6% of the population, the Druzes are represented politically by the Progressive Socialist party under the leadership of Walid Jumblat.

dry cell see battery

dry dock A dry dock is an enclosed basin whose seaward end can be sealed with a movable caisson or gate. Ships are placed in dry docks so that the underwater parts of their hulls can be examined, repaired, cleared, or painted. A dry dock is prepared by flooding the basin with water until the level is the same on both sides of the gate. The gate is then removed, and the ship is maneuvered into the basin and secured with lines so that it sits exactly parallel to the sides of the dock. The entrance is then closed, and the basin is pumped dry. As the water is pumped out, the flat bottom of the ship comes to rest on a line of keelblocks arranged on the bottom of the dry dock. The keelblocks are high enough to allow the outer bottom of the ship to be examined or worked on.



A floating dock (left) *lies partially submerged as a ship enters it. Ballast is then adjusted so that the entire dock holding the ship rises above the water. After a ship enters a dry dock* (right), *the sea gates are closed and all the water is pumped out, permitting work to proceed below the vessel's waterline.*

A floating dry dock is a mobile structure, usually built of steel. Water is pumped into its hollow walls and pontoon floor to act as ballast, lowering the dock in the water as a ship enters it. Pumping the water out raises the dock floor above water level. Some floating docks are large, complex structures with their own propulsion engines, repair machinery, and crew's quarters.

Dry Tortugas [tor-too'-guhz] The Dry Tortugas, a group of eight small islands in the Gulf of Mexico, are part of Florida and lie about 110 km (70 mi) west of Key West. Fort Jefferson (begun 1846), which was used as a prison until 1874, and became a national monument in 1935, is here. The islands are known for their abundant bird and marine life. Ponce de León discovered the islands in 1513, and they were annexed by the United States in 1819.

dryads see nymphs

Dryden, John The English author John Dryden, b. Aug. 9, 1631, d. May 1, 1700, called himself Neander, the "new man," in his *Essay of Dramatic Poesy* (1668), and implied that he was a spokesman for his generation and the embodiment of its tastes (see AUGUSTAN AGE). He achieved a preeminence that supported this claim, excelling in comedy, heroic tragedy, verse satire, translation, and literary criticism—genres defined as representative of the RESTORATION.

In 1657, Dryden wrote his first notable poem, "Heroic Stanzas," a memorial on the death of Oliver Cromwell, while serving briefly in the Commonwealth government; in 1660, however, he celebrated the restoration of Charles II in "Astraea Redux." He was elected a fellow of the Royal Society in 1663. In 1667 he published "Annus Mirabilis," which described the English naval victory over the Dutch and praised the fortitude of the English people during the great fire of London (1666). Dryden was subsequently appointed poet laureate, a position that he lost in 1688 for political reasons.

Dryden's major satires were published during his tenure as poet laureate. "Absalom and Achitophel" (1681) attacked Puritan attempts to deny the throne to the legitimate heir, satirized the first earl of Shaftsbury, and proved Dryden a master of the heroic couplet. "Mac Flecknoe" (1682), a satire on Dryden's literary enemy, Thomas SHADWELL, and "The Medal" (1682), another blow against Shaftsbury and the Whigs, followed. Dryden's shifting religious affiliations are reflected in "Religio Laici" (A Layman's Religion, 1682), a poem defending the Anglican church, and in "The Hind and the Panther" (1687), a defense of Catholicism, to which he converted at a politically inauspicious time.

During these years Dryden also wrote essays and plays, including tragedies such as *The Conquest of Granada* (1670–71) and *All for Love* (1677), the latter of which re-created the story of Antony and Cleopatra and demonstrated Dryden's attempt to adhere to the classical unities, and comedies such as *The Wild Gallant* (1663) and *Marriage à la Mode* (1673). His essays, many of which are prefaces to his plays, constitute the first considerable English literary criticism.

Dryden is, however, still best known for his poetry, which exhibited strength and polished elegance and, above all, assured public character. These qualities are evident in the fine and venomous allusiveness of "Mac Flecknoe," the high argument and biblical-heroic-Miltonic parodies of "Absalom and Achitophel," the urbane conversational wit of "To My Dear Friend Mr. Congreve" (1694) that Dryden prefixed to William Congreve's play *The Double Dealer*, and the dignified grief of "To the Memory of Mr. Oldham" (1684).

John Dryden, English poet, dramatist, and critic, appears in this portrait by Sir Godfrey Kneller. Poet laureate of England (1668–88), Dryden was the acknowledged literary arbiter of the later 17th century, a period often referred to as the Age of Dryden. (National Portrait Gallery, London.)

drypoint [dry'-poynt] Drypoint, an ENGRAVING technique, produces a softness of line on a finished print that is unlike the sharp, clear line of the typical engraving. The line is made by cutting into a polished copper plate with a steel- or diamond-pointed stylus, held like a pencil. As the stylus is dragged over the surface of the plate it leaves a shaving, or burr, an uneven ridge of metal on each side of the incised line. Most engraving tools leave a small burr, but it is usually rubbed away by the engraver before the plate is printed. In the case of drypoint the rough burr is left to catch and hold ink. The printed line that results is slightly blurred and—relative to how deeply the line has been cut—shows a rich black, producing a print with subtle gradations of light, shadow, and tone. The burr wears off quickly during printing, and late impressions of a drypoint work often lose much of their soft, uneven tonal quality. The technique is frequently used together with other intaglio processes.

du Barry, Jeanne Bécu, Comtesse [due bah-ree'] The comtesse du Barry, originally named Jeanne Bécu, b. Aug. 19, 1743, d. Dec. 8, 1793, became the mistress of King LOUIS XV of France in 1769. Unlike her predecessor, Madame de POMPADOUR, du Barry wielded little political power. She retired from court on the accession (1774) of Louis XVI. During the French Revolution du Barry helped royalist emigrés in England. As a result she was arrested and guillotined.

Du Bois, W. E. B. [doo boys'] William Edward Burghardt Du Bois, b. Great Barrington, Mass., Feb. 23, 1868, d. Aug. 27, 1963, was a lifelong advocate of world peace and a leading champion of the liberation of Africans and people of African descent. A Phi Beta Kappa graduate of Fisk and Harvard universities and the first black to be awarded (1895) a Ph.D. from Harvard, Du Bois, in more than 20 books and more than 100 scholarly articles, pioneered both in historical studies of the black experience and in sociological explorations into African-American life. His argument, expressed lyrically and with passion in *The Souls of Black Folk* (1903), that an educated black elite should lead blacks to liberation,

W. E. B. Du Bois, a scholar and black civil rights leader, was the founder and guiding force behind the Niagara Movement, out of which grew (1909) the National Association for the Advancement of Colored People (NAACP). Du Bois later devoted himself to pan-Africanism, becoming a citizen of Ghana.

contrasted sharply with Booker T. Washington's emphasis on industrial training for blacks and virtual silence on the questions of social and political equality.

With the aim of ending racial discrimination, Du Bois founded (1905) the Niagara Movement, a forerunner of the National Association for the Advancement of Colored People (NAACP), which he helped organize in 1909 and for which he edited *Crisis* from 1910 to 1934. For decades this was essential reading for all those interested in the fate of black people. Du Bois resigned from the NAACP in 1934 following a dispute in which he argued that blacks should make segregated schools and other institutions serve them even as they struggled to eliminate the racism that had created them. He returned to the NAACP in 1944 after a 10-year absence but was forced to resign in 1948 when his association with the cause of world peace, his expressed admiration for the USSR, and his articulate condemnation of racial oppression at home and abroad made him a liability to the organization in a time of political reaction and anticommunist hysteria.

A pariah in many quarters of the black community throughout the 1950s, Du Bois spent his last years in virtual exile, but he lived to see advances in racial relations in the United States and the coming of independence—which he had helped make possible—to much of Africa. At the age of 93, Du Bois joined the U.S. Communist party before renouncing his U.S. citizenship and becoming (1963) a citizen of the West African nation of Ghana. He was at work on a monumental study of African culture, the *Encyclopedia Africana,* at the time of his death.

Du Camp, Maxime Maxime Du Camp, b. Feb. 8, 1822, d. Feb. 9, 1894, was a French writer and journalist best known for the photographs that he took on a trip with Gustave Flaubert to the Near East in 1849–51. The journey exemplifies the French romantics' fascination with the Orient, and the pictures are a classic example of early topographical photography. Of the 200 calotypes Du Camp made while traveling with Flaubert, 125 appear in *Égypte, Nubie, Palestine et Syrie* (1852), one of the first books illustrated with original photographs. Du Camp published a memoir of the trip, *Le Nil, Égypte et Nubie* (1852), and *Souvenirs littéraires* (1882–83), translated as *Reflections of a Literary Life* (1893). As editor of *La Revue de Paris,* Du Camp serially published (1856–57) Flaubert's *Madame Bovary.*

Du Fu (Tu Fu) [doo-foo] Du Fu, 712-70, considered China's greatest poet by many critics, traced his ancestry back to the 3d-century Confucian scholar Du Yu. A precocious child and son of a scholar-official, Du Fu nonetheless failed his government examinations in 736. After a second unsuccessful attempt to secure a career as a scholar-official, he was able to obtain a minor post before being caught up in the An Lushan rebellion in 755. He was captured by the rebels but escaped and joined the imperial court. After a period of retirement (760–65) at his hut near Chengdu, he spent the last years of his life traveling.

Du Fu had met the older poet Li Bo in 744 and was deeply influenced by him. The greater part of Du Fu's 1,457 surviving poems were written during the last 12 years of life. He was a master of Lü Shi, or "regulated verse," which requires lines of five or seven words arranged into eight-line stanzas according to a strict rhyme-scheme.

du Gard, Roger Martin see Martin du Gard, Roger

du Guesclin, Bertrand [doo gek-lan', ber-trahn'] Bertrand du Guesclin, b. *c.*1320, d. July 13, 1380, was the most renowned French commander of the Hundred Years' War. Originally from Brittany, du Guesclin entered the service of the king of France, and in May 1364 he won the battle of Cocherel in Normandy against the opponents of Charles V. Except for this victory, he was unsuccessful in pitched battles, losing at Auray (1364) and Nájera (1367).

It is ironic that du Guesclin acquired fame as a symbol of chivalry, for he was most successful at such unchivalrous pursuits as brigandage and guerrilla warfare. He succeeded in installing the pro-French Henry II on the throne of Castile in 1369 and was named constable of France in 1370; his tactics brought military success after years of French defeats.

du Maurier, Daphne [doo mor'-ee-ay] Daphne du Maurier, b., London, May 13, 1907, d. Apr. 19, 1989, is best known as the author of *Rebecca* (1938; film, 1940), a Gothic romance about love and mystery on an English estate. The granddaughter of the artist and writer George du Maurier and the daughter of the actor Sir Gerald du Maurier, she wrote other romances and historical novels, including *Jamaica Inn* (1936; film, 1939), *My Cousin Rachel* (1951; film, 1952), and *The Scapegoat* (1957; film, 1959). Among her other publications are several short-story collections and biographies of Branwell Brontë, Sir Francis Bacon, and her father, as well as the autobiographical *Myself When Young* (1977).

du Pont (family) The du Pont family, which settled in the United States at the end of the 18th century, founded (1802) one of the largest companies in the world (E. I. du Pont de Nemours & Company, known as the Du Pont Company) and has been prominent in public and military affairs, state and national politics, and philanthropy.

Pierre Samuel du Pont de Nemours, b. Dec. 14, 1739, d. Aug. 6, 1817, was a French economist. A PHYSIOCRAT, he served as France's inspector general of commerce from 1774 to 1776. Because his politically moderate views brought him increasingly into conflict with the Jacobins, he fled to the United States in 1800.

His son **Éleuthère Irénée du Pont**, b. June 24, 1771, d. Oct. 31, 1834, was the founder of the Du Pont Company. In 1788 he began to train under the French scientist Antoine LAVOISIER at the French gunpowder works. A political moderate like his father, Éleuthère brought his family to the United States in 1799. In 1802 he established the Du Pont Company on the Brandywine River, near Wilmington, Del. The company at first specialized in the manufacture of high-quality GUNPOWDER.

Éleuthère Irénée's nephew **Samuel Francis du Pont**, b. Bergen Point, N.J., Sept. 27, 1803, d. June 23, 1865, was an American naval officer. During the 1840s he was one of those in charge of establishing the U.S. Naval Academy. In 1861, early in the Civil War, he commanded the blockading squadron in the southern Atlantic and in November captured Port Royal, S.C.

Pierre Samuel du Pont, b. Wilmington, Del., Jan. 15, 1870, d. Apr. 5, 1954, a great-grandson of Éleuthère Irénée, was president of the company from 1915 to 1920 and chairman of the board from 1923 to 1940. Under his leadership Du Pont became a professionally managed corporation, its products including synthetic fibers, rubber, and chemicals.

Pierre Samuel du Pont IV, b. Wilmington, Del., Jan. 22, 1935, was elected Republican governor of Delaware in 1976 and reelected in 1980.

Éleuthère Irénée du Pont founded (1802) the gunpowder company that became the industrial dynasty known today as E. I. du Pont de Nemours & Company. Now one of the largest and most influential industrial concerns in the world, du Pont produces textiles, rubber, chemicals, paint, and other synthetics.

Dual Monarchy see AUSTRIA-HUNGARY

dualism Dualism is any theory or system of thought that recognizes two and only two independent and mutually irreducible principles or substances, which are sometimes complementary and sometimes in conflict. Dualisms are distinguished from MONISMS, which admit only one element or kind of element, and from PLURALISMS, which admit more than two elements or kinds of elements. The polarities of a dualism are distinguished from the thesis and antithesis of a DIALECTIC, in that the former are stable and mutually exclusive and the latter are dynamic, always tending toward synthesis.

Dualisms are of two basic kinds, metaphysical and epistemological. Metaphysical dualisms admit two substances, such as world and God, or two principles, such as good and evil, as a means of explaining the nature of reality. René DESCARTES argued a metaphysical dualism between mind—thinking substance—and body—extended substance. He held that all elements of reality are ultimately one or the other of these two heterogeneous substances. Epistemological dualisms use two substances or principles, such as consciousness and phenomena or subject and object, to analyze the knowing process.

PLATO's being and becoming, ARISTOTLE's form and matter, Immanuel KANT's noumena and phenomena, yin and yang in Chinese philosophy, and the traditional issues of God and humankind, space and time, and nature and nurture are among other famous dualisms.

Duarte, José Napoleón José Napoleón Duarte, b. Nov. 23, 1926, was president of El Salvador from 1980 to 1982 and again from 1984 to 1989. In 1960 he helped found the reformist Christian Democratic party. Forced into exile by the right-wing government in 1972, Duarte returned after a 1979 coup set up a military-civilian junta that proved ineffective in the face of a full-scale civil war between leftist guerrillas, government troops, and rightist "death squads." In December 1980 a new junta installed Duarte as president, but right-wing forces regained power in the 1982 elections. Duarte regained the presidency in May 1984 elections and, with continued U.S. backing and the civil war stalemated, instituted a number of reforms before falling seriously ill with cancer in 1988.

Dubai [doo-by'] Dubai is an emirate and one of the seven states forming the UNITED ARAB EMIRATES on the southern shore of the Persian Gulf. Its population is 419,104 (1985). Actually a city-state, Dubai has developed from the villages of Deira and Dubai in the 1930s into an important oil producer and leading commercial center. It has a harbor on the gulf, with extensive docking facilities at Port Rashid, and an international airport.

Dubček, Alexander [dub'-chek] Alexander Dubček, b. Nov. 27, 1921, was a Slovak Communist politician who became leader of the Czechoslovak Communist party in January 1968. He pledged himself to political liberalization, promising his countrymen "communism with a human face." As the drive toward greater freedom gained momentum, Soviet leaders began to fear that Dubček might lead Czechoslovakia out of the Soviet bloc. Military forces of the Warsaw Pact invaded Czechoslovakia on Aug. 20–21, 1968. Stripped of power, Dubček was expelled (June 1970) from the Communist party and went to work for the forestry administration. Rehabilitated in the liberalization of 1989, he was elected chairman of the parliament.

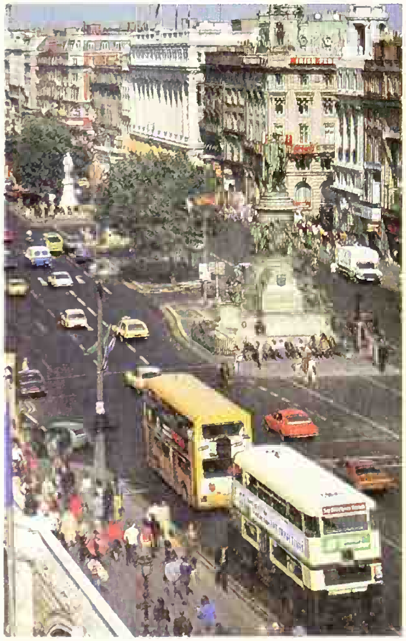
Dubinsky, David [doo-bin'-skee] David Dubinsky, b. Feb. 22, 1892, d. Sept. 17, 1982, was the longtime leader of the INTERNATIONAL LADIES' GARMENT WORKERS' UNION (ILGWU). A native of Russian Poland, Dubinsky was exiled to Siberia at the age of 16 for organizing bakery workers. He escaped and made his way to the United States in 1911. He soon became an officer in the ILGWU, serving as its president from 1932 to 1966. A vice-president of the American Federation of Labor in 1934, he helped found the American Labor Party in 1936, the Liberal Party in 1944, Americans for Democratic Action in 1947, and the International Confederation of Free Trade Unions in 1949.

Dublin Dublin is the capital and largest city of the Republic of Ireland. It forms a county of the same name with an area of 922 km^2 (356 mi^2) and a population of 1,021,449 (1986); the city proper has a population of 502,749 (1986). It lies on both banks of the River Liffey, 3 km (2 mi) from Dublin Bay. Its name in Irish is Baile Átha Cliath (Town of the Hurdle Ford); its conventional name is derived from the original Irish *Dubh Linn*, "black pool."

Contemporary City. Dublin is by far the most important commercial and industrial city in Ireland. The Guinness brewery is a major employer. Food processing and distilling, shipbuilding, iron founding, and glass manufacturing are also important. The main docks lie at the head of Dublin Bay, with only smaller craft able to reach the quays along the Liffey. The port handles about half the foreign trade of the republic.

Dublin retains a rural flavor in part because of the low buildings, squares, and wide streets built during the late 1700s. Among the few existing structures predating this period are Dublin Castle (begun about 1200), Christ Church and St. Patrick's Cathedral (Church of Ireland; both originally 12th century), and Kilmainham Hospital (1679). Leinster House, built for the duke of Leinster (1745), now serves as the Parliament building. Other notable 18th-century structures are the Custom House and the Four Courts. Phoenix Park contains a James Joyce museum; the 19th-century National Library and National Museum serve as depositories of Irish antiquities. TRINITY COLLEGE (1591) and University College (1851) are in the city. The ABBEY THEATRE, founded in 1902, has encouraged the writing and performance of plays with a strongly Irish character.

History. The earliest known settlement on the site was made by the Vikings in the 9th century. In time they were absorbed by the native Irish but were followed by the English, who came in 1170, built a castle, and developed a small commercial town beside it. Dublin became a pre-



(Left) *O'Connell Street, Dublin's widest thoroughfare, was known as Sackville Street before being renamed for Irish nationalist Daniel O'Connell (1775–1847), whose statue is one of several along the center of the boulevard.* (Below) *Among Dublin's landmark structures overlooking the River Liffey is the Four Courts, seat of Ireland's central courts of justice.*

dominantly Protestant city closely controlled by the English during the Reformation—known as the Protestant Ascendancy. In the late 17th century it received numbers of Huguenot refugees from France. During the 19th century Dublin was transformed, largely by immigration from the rest of Ireland, into a Roman Catholic city. By the early 20th century it had become the focus of the Irish nationalist movement and in 1916 was the scene of the Easter Rising against British rule. In 1922 it became the capital of the Irish Free State, which later became the Irish Republic.

Dubnow, Simon [dub'-nawf] Simon Dubnow, b. Russia, Sept. 10 (N.S.), 1860, d. December 1941, was the most important Jewish historian of his era and a participant in the ideological debates concerning Jewish nationalism. He tried to resolve the conflict between universalism and particularism with his theory of a "state of nationalities," a multinational state in which each nationality would maintain internal self-rule but would join with other national groups in a mutually sustaining, strong state. Dubnow thought this the basic direction of European political life; therefore he opposed Zionism. His "Letters on Old and New Judaism" appeared between 1897 and 1907 in the Russian periodical *Voshkod.*

Dubos, René [doo-boh'] René Jules Dubos, b. Feb. 20, 1901, d. Feb. 20, 1982, a French-American microbiologist, discovered the first commercially produced antibiotic and made other important contributions to the study of bacterial diseases. In 1939, Dubos isolated tyrothricin from *Bacillus brevis,* which is effective in treating certain bacteria-produced diseases in humans. The discovery of tyrothricin influenced later work on antibiotics. Dubos's writings include *So Human an Animal* (1968), awarded the Pulitzer Prize for general nonfiction.

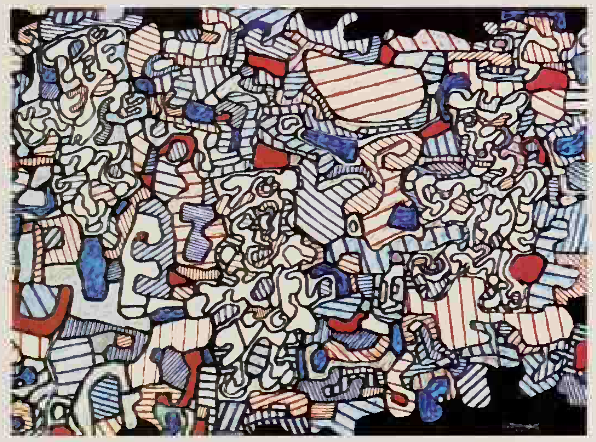
Dubrovnik [doo'-brawv-nik] Dubrovnik, a walled port in Croatia, Yugoslavia, lies on the Dalmatian coast of the Adriatic Sea, at the foot of Mount Srdj. The population of Dubrovnik is 66,131 (1981). Its harbor facilities are at the suburb of Gruz. A resort and market center, Dubrovnik manufactures silk, leather goods, cheeses, and liquor and refines oil. Dubrovnik's landmarks include the cathedral (begun 1190), two 14th-century convents, the 15th-century Rector's Palace, and the 9th-century city walls.

Founded by the Romans in the 7th century, the city was called Ragusium. Also settled by Slavs, it paid allegiance to the Byzantine Empire, Venice, Hungary, and the Ottoman Empire in succession, but it retained virtual independence until taken (1808) by Napoleon I's forces. Assigned to Austria in 1815, Dubrovnik became part of Yugoslavia at the end of World War I.

Dubuffet, Jean [due-bue-fay'] Jean Dubuffet, b. July 31, 1901, d. May 12, 1985, was perhaps the most important French artist of the post–World War II period. His raw, crude drawings and paintings reflect a deliberate renunciation of the Western ideal of beauty in favor of the spontaneous vigor of the art of children and the insane, which he collected. In later life he created many large-scale sculptural works, including *Group of Four Trees* (New York City, 1972) and *Monument with Standing Beast* (Chicago, 1984).

Among the most outstanding of Dubuffet's paintings are the *Métro* series (1944), done in imitation of children's drawings, and the *Corps de Dame* series (1950), in which he incorporated sand, earth, plaster, and cinders. The *Theaters of Memory* series (1970s) added elements of his early work to the purely abstract configurations of the *Hourloupe* series (1962–66).

Dubuffet's paintings have often been compared with Willem de Kooning's, but Dubuffet's style, no matter how apparently disordered, displays a witty and sophisticated French taste within firm design elements.



The jigsaw-puzzle forms of Jean Dubuffet's The Hare Path *(1964) represent only one of the styles he adopted. Dubuffet specialized in primitive forms, both for their emotive qualities and abstract configurations. (Stedelijk Museum, Amsterdam.)*

Dubuque [duh-buek'] Dubuque, a city in northeastern Iowa on the Mississippi River, is the seat of Dubuque County. The city has a population of 57,546 (1990) and is a trade, rail, and industrial center for a rich agricultural region. Named for Julien Dubuque, it was settled after the Black Hawk Treaty ended local Indian wars in 1832. The University of Dubuque, Clarke College, Loras College, and several seminaries are located there.

Dubuque, Julien [due-buek'] Julien Dubuque, b. Jan. 10, 1762, d. Mar. 24, 1810, a French-Canadian adventurer, was the first white settler in present-day Iowa. In 1788 he received exclusive permission from the Fox Indians to work the lead mines in the Iowa area (then part of Spanish Louisiana). The city of Dubuque is named for him.

Duccio di Buoninsegna [doot'-choh dee bwoh-neen-sayn'-yah] Duccio di Buoninsegna, *c.*1255–*c.*1319, was the leading painter of his time in Siena, Italy. Although he remained faithful to a fading Byzantine tradition, Duccio was an extremely creative and subtle artist.

In 1285 the Church of Santa Maria Novella in Florence commissioned from Duccio a large (4.5-by-2.75-m/15-by-9-ft) wooden panel of the *Madonna and Child Enthroned*, called the *Rucellai Madonna* (Uffizi, Florence). In the painting six angels, who are kneeling in mid-air against a gold background, hold the throne aloft. Nearly 25 years later, the Cathedral of Siena commissioned (1308) the *Maestà* (Cathedral Museum, Siena), a broad panel painted on both front and back: a Madonna and Child with saints on one side and 26 scenes of the Passion, Death, and Resurrection of Christ on the other. Excellently crafted, richly colored, and superbly designed, the *Maestà* is evidence of Duccio's mastery and of his influence on subsequent Sienese art.

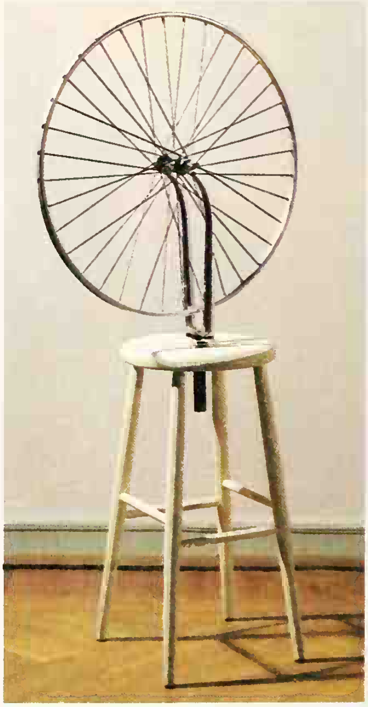
Duchamp, Marcel [doo-shahm'] Marcel Duchamp, b. July 28, 1887, d. Oct. 2, 1968, was a French painter and theorist, a major proponent of DADA, and one of the most influential figures of avant-garde 20th-century art. After a brief early period in which he was influenced chiefly by Paul CÉZANNE and Fauve color (see FAUVISM), Duchamp developed a type of symbolic painting, a dynamic version of facet CUBISM (similar to FUTURISM), in which the image depicted successive movements of a single body.

In 1912, Duchamp painted his famous *Nude Descending a Staircase,* which caused a scandal at the 1913 ARMORY SHOW in New York City. In the same year he developed, with Francis PICABIA and Guillaume APOLLINAIRE, the radical and ironic ideas that independently prefigured the official founding of Dada in 1916 in Zurich. In Paris in 1914, Duchamp bought and inscribed a bottle rack, thereby producing his first ready-made, a new art form based on the principle that art does not depend on established rules or on craftsmanship. Duchamp's ready-mades are ordinary objects that are signed and titled, becoming aesthetic, rather than functional, objects simply by this change in context. Dada aimed at departure from the physical aspect of painting and emphases in ideas as the chief means of artistic expression.

In 1915, Duchamp began his major work, *The Large Glass*, or *The Bride Stripped Bare by Her Bachelors, Even* (1915–23), a construction of wire and painted foil fitted between plates of transparent glass. In 1918 he completed his last major painting, *Tu m',* a huge oil and graphite on canvas, a unique combination of real and painted objects and illusionistic and flat space. Following his maxim never to repeat himself, Duchamp "stopped" painting (1923) after 20 works, but between 1946 and 1949 he created his final work, the *Étant Donnés* (Philadelphia Museum of Art).

Duchamp-Villon, Raymond [vee-yohn'] Raymond Duchamp-Villon, b. Nov. 5, 1876, d. Oct. 7, 1918, whose given name was Pierre Maurice Raymond Duchamp, was a French sculptor and a key figure in cubist art (see CUBISM) before World War I. He was the brother of Marcel DUCHAMP and Jacques VILLON. After illness interrupted his medical studies in Paris (1894–98), Duchamp-Villon turned to sculpture. He began to exhibit regularly from 1905, contributing to the Salon d'Automne, to the 1912 Section d'Or exhibition in Paris, and to the 1913 ARMORY SHOW in New York. During Duchamp-Villon's short career as a sculptor, he moved from ART NOUVEAU to the style of RODIN to cubism and FUTURISM. His most famous work is *The Horse* (1914; bronze), in which he transformed a horse-and-rider image into a nonfigurative symbol of the machine age.

Duchesne, Saint Rose Philippine Rose Philippine Duchesne, b. Aug. 29, 1769, d. Nov. 18, 1852, was a pioneer Roman Catholic educator and missionary in the United States. Born in France, Duchesne joined the Society of the Sacred Heart, a women's religious community, in 1804, and in 1818 she founded a branch of the society in the United States, where she established schools, convents, and orphanages along the American frontier at St. Charles (1818) and St. Louis (1827), Mo., and worked (1841–42) as a missionary among the Potawatomi Indians of Kansas. She was canonized in 1988. Feast day: Nov. 17.



The French artist Marcel Duchamp influenced movements from cubism to surrealism during the 20th century. His innovations included "ready-mades," assemblages of everyday items. The ready-made Bicycle Wheel *(1913) anticipated Dadaism in its rejection of traditional artistic subject matter.*

duck Duck is the name given to most of the smaller species of wildfowl in the family Anatidae, order Anseriformes, or gooselike birds. Other members of this order are the screamers, geese, and swans. The word *duck* does not, however, correspond with any precise taxonomic classification. Some ducks are commonly called geese—for example, the pygmy goose and the maned goose—and some, such as the merganser, are called neither duck nor goose.

General Characteristics. Ducks are freshwater and marine birds that have streamlined bodies and sleek, waterproof plumage. The feathers of the male, or drake, of many genera have striking color patterns that are sometimes iridescent. A duck's front toes are fully webbed for swimming and diving; on land, a duck waddles because its legs are placed far apart and usually well to the rear. Many ducks are excellent fliers and migrate thousands of miles between breeding and winter grounds. The bill is typically spatulate and has a rounded tip. Lamellae (bony plates) or serrations (teethlike notches) on the inner edge of each jaw are used to strain small plants and animals from water or to hold food such as fish.

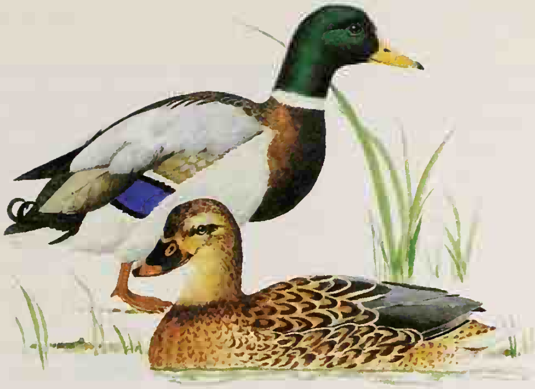
Ducks lay 2 to 16 eggs in nests located on the ground, in tree holes, in rock clefts, or in burrows. In each case, materials available at the nest site are used. Ducks that burrow cannot dig holes for themselves and so occupy former nesting sites of animals such as woodpeckers or rabbits. The nests are usually lined with down feathers, which the incubating female plucks from her breast. Newly hatched young, known as ducklings, are precocial: they are covered with down, feed themselves, and are capable of swimming.

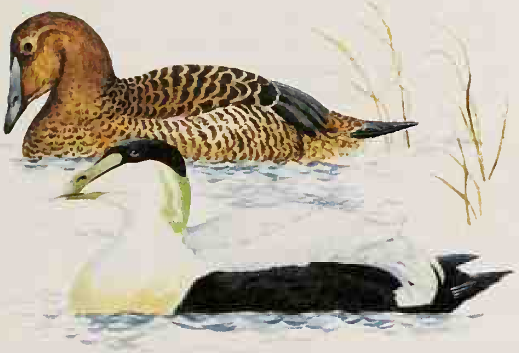
Most ducks molt their body feathers twice annually. Flight feathers are molted only once a year, during which time (3 to 4 weeks) the birds cannot fly.

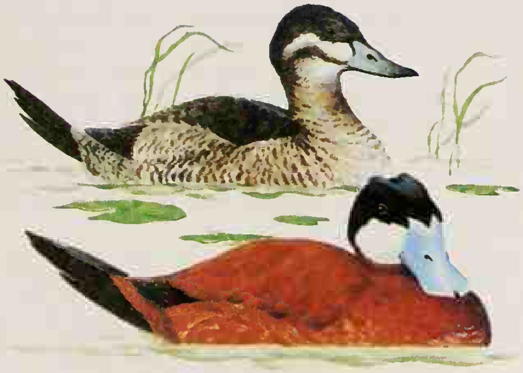
Types of Ducks. The wildfowl family is classified into 10 or 11 tribes, of which 8 contain species commonly known as ducks. About 116 species of ducks are known.

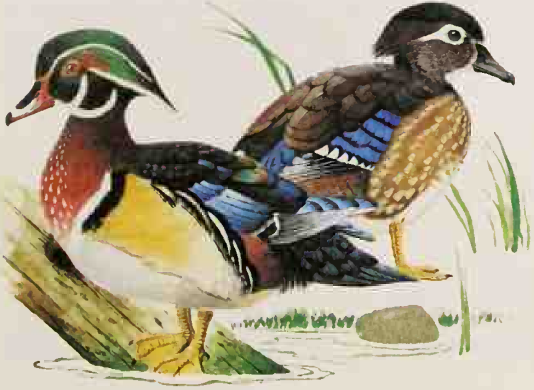
Whistling ducks are included in the same subfamily, Anserinae, as swans and geese. They are small, tropical and subtropical species that have long legs and necks. The male and female resemble each other and share parental duties. Both sexes produce a high-pitched whistling sound. The Australian freckled duck, *Stictonetta naevosa,* is a rare water bird and is often placed in a tribe by itself, Stictonettini.

The rest of the ducks are classified as tribes of the subfamily Anatinae. Typically, sexes of these groups differ in appearance and only the female rears the young.


mallard


common eider


ruddy duck


wood duck

The mallard is a dabbling duck, feeding in ponds and marshes. The male (rear) *has a green head and brown breast separated by a white neck ring. The common eider, a sea duck that feeds on shellfish, is the largest duck found in North America. The female* (rear) *is valued for its down, the soft feathers found on the breast. The ruddy duck has a long, stiff tail, which it carries straight out from its body. During the breeding season, the male* (front) *has a blue bill. The wood duck nests in tree hollows as high as 15 m (50 ft) aboveground. The coloration of the male* (front) *includes iridescent greens and blues with white striping. The female is more sedately colored.*

Shelducks, tribe Tadornini, are found worldwide except for North and Central America. They nest in burrows; unlike most tribes, both sexes care for the brood. Steamer ducks, native to South America, are three species that are either classified as shelducks or placed in a separate tribe, Tachyerini. These large sea ducks are divers; two species cannot fly. Perching ducks, tribe Cairinini, of which the Carolina wood duck, *Aix sponsa,* is an example, rest on tree branches and nest in tree holes. Many Cairinini are extremely handsome ducks, with metallic hues and bold markings on their feathers. Dabbling, or surface-feeding ducks, tribe Anatini, are most prevalent in the Northern Hemisphere. These ducks, which include the Mallard, *Anas platyrhynchos,* have short legs and necks; they feed underwater by immersing only the front part of the body.

Diving ducks have short bodies and large feet, with legs placed close to the rear. Pochards, tribe Aythyini, are mostly freshwater ducks that are distributed worldwide; they include the canvasback, *Aythya vallisneria,* of North America. Mergansers (tribe Mergini), scoters, and goldeneyes are diving ducks that live mostly near the sea. Eiders are classified either as part of the Mergini tribe or as a separate tribe, Somateriini. The stifftails, tribe Oxyurini, are freshwater diving ducks with flat, broad bills and long, rigid tails that aid in underwater swimming. The North American ruddy duck, *Oxyura jamaicensis,* is an example.

Distribution. Ducks inhabit every continent but Antarctica. Their greatest distribution is now in the northern temperate and Arctic regions, where they inhabit areas rich in shallow lakes and marshes. Sea ducks live near the coast or in bays.

Importance. Humans have long exploited the annual period of flightlessness in order to net or corral wild ducks, which are killed for food. Duck hunting has been a popular sport for centuries. Today many populations of wild ducks are threatened by the loss of their wetland habitat resulting from pollution and from drainage for housing development.

Ducks are readily domesticated, but only two species have been bred by humans, for meat, egg, or down production. The mallard was domesticated more than a thousand years ago in China. The Muscovy duck, *Cairina moschata,* was domesticated in South America before the arrival of the Spaniards.

The down with which the female eider lines her nest is collected during and after incubation for use in eiderdowns and padded clothing. Its insulating properties are still unsurpassed by artificial fibers.

The duck-billed platypus or duck mole uses its broad, flat tail to steer itself while swimming in freshwater rivers.

duck-billed platypus The duck-billed platypus, *Ornithorhynchus anatinus,* is an egg-laying mammal of eastern Australia. It is the only member of the family Ornithorhynchidae, order Monotremata. This semiaquatic animal has a flat, rubbery bill and a beaverlike tail. The platypus is about 61 cm (24 in) long, weighs about 1.8 kg (4 lb), and has a coat of dark brown to yellow fur. Webbed feet enable the platypus to swim well. Each hind foot of the male has a poison spur that can kill small animals and inflict painful wounds on larger ones. Crushing its food with the horny plates of the bill and mouth, the platypus each day eats about half its own weight in worms, insect larvae, mollusks, crustaceans, and vegetation, all consumed underwater. When feeding, it shuts its eyes, ears, and nose, but electrosensors in its bill signal the presence of prey.

Mating takes place in late winter and early spring. The female digs a burrow 4.6 to 18 m (15 to 60 ft) long, at the end of which she builds a nest and lays her eggs, usually two. The eggs are incubated for 8 to 10 days. After the eggs hatch, the young suck milk from the nippleless abdominal mammary glands of the mother. The young are weaned at about 5 months and reach sexual maturity in a year. The life span is about 10 years. The enemies of the platypus include large fish.

See also: MONOTREME.

ductility see MATERIALS TECHNOLOGY

ductless glands see ENDOCRINE SYSTEM; HORMONES

due process Due process of law is a concept in U.S. and English jurisprudence that establishes limits to the powers of government, specifically against the arbitrary deprivation of life, liberty, or property.

First enunciated in the Magna Carta (1215)—"No free man shall be arrested or imprisoned except by the lawful judgment of his peers or by the law of the land"—the 5th Amendment (1791) to the Constitution of the United States established this protection with the words: "Nor shall [any person] be deprived of life, liberty or property without due process of law." The 14th Amendment (1867) extended the protection to cover acts of state governments.

In U.S. jurisprudence the concept has both substantive and procedural aspects. The substantive interpretation means that legislation must be reasonably related to the attainment of a legitimate government objective and must use the least burdensome method of achieving that objective. The procedural aspects of due process are not fixed or technical, nor do they include any specific right beyond prior notice and a fair hearing; they vary, imposing a "fairness" restraint on governmental action.

Following a series of political maneuvers and insults directed against him, Vice-President Aaron Burr challenged Alexander Hamilton to a duel of honor, which took place July 11, 1804, at Weehawken, N.J. Hamilton refused to fire and was fatally wounded.

duel [doo'-ul] A duel is a fight between two persons with weapons, usually in the presence of witnesses, to settle an argument or point of honor. Its earliest form, judicial duel or trial by battle, was established (AD 501) by Gundobad, king of the Burgundians, and came to be accepted as a method of settling feuds throughout western Europe. The spread of knighthood (see KNIGHT) led to the development of the duel of CHIVALRY, the first of which is thought to have been fought (858) by Emperor CHARLES II and his brother LOUIS THE GERMAN. Strictly enforced codes of conduct were eventually introduced, from which the duel of honor evolved by the late 15th century.

Dueling reached its peak in the mid-17th century, when gentlemen challenged each other to fight on the slightest pretext. After the initial challenge, each duelist chose a friend, or second, to witness and assist at the event. Swords, and eventually pistols, were the most popular weapons employed. Duels did not necessarily result in the death of a combatant; the drawing of blood was usually sufficient to determine the outcome of the encounter. So-called petticoat duels, fought between ladies, also took place.

Dueling was formally outlawed in Britain in 1888 but was not abandoned in France until after World War I; in Germany it continued to be practiced until the 1940s. In the United States dueling was common in the South during the 1830s and '40s and in California after the gold rush of 1848; it died out before 1900.

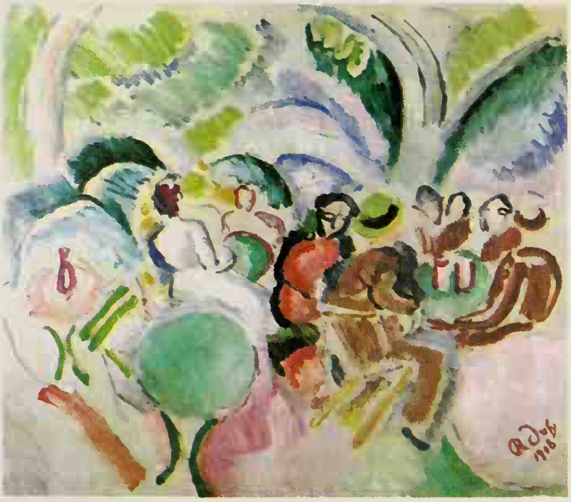
Duer, William [doo'-ur] William Duer, b. Mar. 18, 1747, d. Apr. 18, 1799, was a financier and politician of the American revolutionary period. A member of a wealthy English family, he went to New York in 1768 and soon identified himself with the colonists' opposition to the policies of the London government. Elected (1775) to the New York Congress, he was a delegate (1777–78) to the Continental Congress and a major supplier of matériel to the Continental Army. A leading New York financier, he was assistant secretary of the treasury for a brief time in 1789. In 1792, ruined by unwise speculation, Duer was imprisoned for debt.

Dufay, Guillaume [doo-fay', gee-yohm'] Guillaume Dufay, b. *c.*1400, d. Nov. 27, 1474, was one of the greatest composers of the early Renaissance and the foremost representative of the Burgundian school (see FRENCH MUSIC). Ordained a priest about 1420, Dufay traveled to Paris and then to Italy, where he performed in choirs and at court, and took a degree in canon law. The most celebrated composer of his day and the teacher of many famous musicians, Dufay settled in Cambrai as canon of the cathedral.

Eight complete masses by Dufay survive along with a large number of mass movements. Dufay was a key figure in the development of the cyclic mass, in which unity is achieved by the introduction of the same theme (or a variation) at the beginning of each movement. His secular works include numerous chansons.

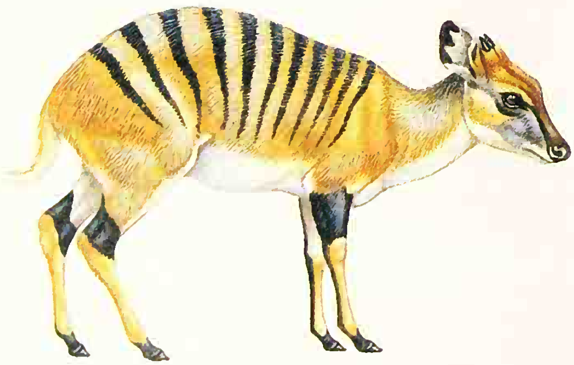
Dufy, Raoul [due-fee', rah-ool'] Raoul Ernest Joseph Dufy, b. June 3, 1887, d. Mar. 23, 1953, was a French artist and a member of the Fauve group (see FAUVISM). The scope of Dufy's work embraced painting, printmaking, and industrial design. His early works are Parisian

The French artist Raoul Dufy painted Le Café à l'Estaque *in 1908, after meeting the founder of Fauvism, Henri Matisse. Dufy abandoned his impressionist style for the energetic brushstrokes and vibrant colors of the Fauvists. (Musée National d'Art Moderne, Paris.)*



scenes and Normandy beaches painted in the late impressionist manner. After 1905, when he saw the work of the Fauves—Matisse, Derain, Marquet, Vlaminck—Dufy's style underwent a decisive change toward the Fauvist richness of color. His paintings such as *Posters at Trouville* (1906), *Street Decked with Flags at Le Havre* (1906; both Musée National d'Art Moderne, Centre Pompidou, Paris), and *The Three Umbrellas* (1906; Beck Collection, Houston) established his reputation as a Fauvist. In 1907–08, Dufy's work passed through a Cézannesque phase, as can be seen in such works as *Green Trees at l'Estaque* (1908; private collection, France). From 1910 on, Dufy became involved in wood engraving and woodcuts for book illustrations. He developed a decorative style characterized by brilliant colors and by superimposed fluid linear patterns. His favorite subjects included bathers, nudes, garden parties, horse races, regattas, and flowers.

duiker [dy'-kur] The duiker is a small, usually solitary antelope, family Bovidae, found in Africa in and south of the Sudan. Forest duikers, genus *Cephalophus,* comprise 10 to 15 species. They have rounded backs, and both sexes have rearward-pointing horns. Forest duikers weigh from 4.5 to 63.5 kg (10 to 140 lb) and are 35.5 to 84 cm (14 to 33 in) high at the shoulder. The gray duiker, *Sylvicapra grimmia,* inhabits open land. It has a straighter back, and typically only males have horns, which are upright.



The banded duiker is a small antelope of western Africa. It uses secretions from its cheek glands to mark the face of its mate as well as paths within its territory. Duikers are unusual antelope because they occasionally eat termites and will kill and eat birds.

Duisburg [doos'-boork] Duisburg (1987 est. pop., 514,600) is an industrial city in the state of North Rhine-Westphalia, Germany, and the largest inland port in Europe. It is located on the east bank of the Rhine River at its junction with the Ruhr River and the Rhine-Herne Canal. Duisburg's industries include shipbuilding, steelmaking, engineering, oil refining, chemical manufacturing, and brewing. The city is also a major railroad hub.

Established in Roman times, Duisburg was a thriving commercial center when it was chartered in 1129. Its industrial eminence began in the 19th century, when the Thyssen steel works was established. Of cultural interest are the Gothic Salvatorkirche and the Lehmbruck Museum, which displays works of the local sculptor Wilhelm LEHMBRUCK. The city was bombed extensively during World War II.

Dukakis, Michael Michael Stanley Dukakis, b. Brookline, Mass., Nov. 3, 1933, a three-term governor of Massachusetts, was the Democratic presidential candidate in 1988. The son of immigrants from Greece, Dukakis graduated from Swarthmore College (1955) and Harvard Law School (1960). He was elected to the Massachusetts legislature in 1962, serving four terms. Elected governor of Massachusetts in 1974, Dukakis was denied renomination in 1978. Reelected in 1982 and 1986, he claimed credit for part of the period's economic resurgence—the "Massachusetts miracle." The state's economy had soured when he declined to run again in 1990. Stressing "competence" over "ideology," Dukakis campaigned for the presidency in 1988 in a manner that many observers found uninspiring. He and his running mate, Sen. Lloyd BENTSEN of Texas, lost to the Republican team, George Bush and Dan Quayle, by 46% to 54% of the popular vote.

Dukas, Paul [due-kah'] Paul Dukas, b. Oct. 1, 1865, d. May 17, 1935, was a French composer. In 1897 he conducted the first performance of his orchestral scherzo *The Sorcerer's Apprentice,* a brilliantly orchestrated work based on a ballad by Goethe. His opera *Ariàne et Barbe-Bleue* (Ariadne and Bluebeard) was produced in 1907 and is generally considered a fine example of postromantic opera. Dukas taught for 25 years at the Paris Conservatory and was also a noted writer and critic. His works show the influence of Richard Wagner and of the impressionist composers.

duke see TITLES OF NOBILITY AND HONOR

Duke, James Buchanan James Buchanan Duke, b. near Durham, N.C., Dec. 23, 1856, d. Oct. 10, 1925, was an American tobacco industrialist and philanthropist whose career originated with a small family business in Durham, N.C. The family firm began concentrating on cigarette production in 1881, and within a few years, led by James, it dominated the national market. In 1890 the Dukes and four competitors merged to form the American Tobacco Company. It achieved such predominance in the industry that in 1911 the Supreme Court ordered its dissolution and reorganization. The Dukes donated large sums of money to hospitals and churches and to Trinity College, a small Methodist institution that later became Duke University.

Duke University Established in 1838 as the Union Institute and Randolph College, and from 1859 known as

Trinity College, Duke University, a coeducational institution in Durham, N.C., adopted its present name in 1924. It is affiliated with the United Methodist church, and has schools of law, theology, medicine, nursing, engineering, and forestry.

Dukhobors see DOUKHOBORS

dulcimer [dul'-sim-ur] The dulcimer is a struck zither, probably originating in the 10th century in Persia where it was called the *santir* (from the Greek *psalterion*). Typically, it was a shallow, trapezoidal wooden box, whose 14 or more courses of 4 metal strings, stretched over bridges, were struck by mallets with curved tips. In the late 17th century, Pantaleon Hebenstreit reportedly enlarged the dulcimer and amazed Europe with his virtuosity, possibly thereby influencing its illustrious mechanized descendant, the pianoforte. The dulcimer has survived as a folk instrument in northern Europe and the United States. In central Europe it has been transformed into the *cimbalom.*

Dulles, Allen Welsh [duhl'-uhs] Allen Welsh Dulles, b. Watertown, N.Y., Apr. 7, 1893, d. Jan. 29, 1969, the brother of John Foster Dulles, headed the CENTRAL INTELLIGENCE AGENCY (CIA) from 1953 to 1961. He helped found the CIA in 1950 and was its deputy director before becoming director. The CIA was greatly expanded under Dulles, but controversies, particularly the disastrous BAY OF PIGS INVASION of Cuba, caused him to resign in 1961. He wrote *The Craft of Intelligence* (1963).

John Foster Dulles, secretary of state (1953–59) under Dwight D. Eisenhower, was a principal architect of U.S. cold-war foreign policy.

Dulles, John Foster John Foster Dulles, b. Washington, D.C., Feb. 25, 1888, d. May 24, 1959, was U.S. secretary of state from 1953 to 1959, during the administration of Dwight D. EISENHOWER, and a leading figure in the COLD WAR. Educated at Princeton University, the University of Paris, and George Washington University, he established a career as a leading figure in international law and finance during the 1920s and '30s.

Dulles emerged during World War II as a major advocate of international involvement within the Republican party. He was a close advisor to Gov. Thomas E. DEWEY of New York, who appointed him to a brief term in the U.S. Senate in 1949. The Roosevelt and Truman administrations, seeking his cooperation for a bipartisan foreign policy, offered Dulles several appointments. In 1945 he was a member of the U.S. delegation to the San Francisco Conference, which founded the United Nations (UN); he was one of the U.S. representatives to the UN. In 1951, Dulles headed the delegation that negotiated the peace treaty with Japan.

Dulles became a leading critic of Democratic foreign policy, which he considered too soft on world communism. He was the primary drafter of the 1952 Republican foreign policy platform, which urged the liberation of Soviet-controlled nations. As secretary of state, however, he abandoned this position when the United States was unable to prevent Soviet suppression of the Hungarian Revolution in 1956. Dulles threatened massive retaliation with nuclear weapons in the event of Soviet aggression and declared that the will to go "to the brink" of war was a necessary aspect of U.S. diplomacy.

Dulong, Pierre Louis [due-lohn'] Pierre Louis Dulong, b. Feb. 12, 1785, d. July 19, 1838, was a French chemist and physicist who discovered (1811) the spontaneously explosive oil nitrogen trichloride, clarified (1816) the composition of the oxides of nitrogen, and collaborated (1819) with Jöns Jakob Berzelius in determining the gravimetric composition of water. Dulong also worked with the mathematical physicist Alexis Thérèse Petit (1791–1820) on research concerning thermal expansion and temperature measurements. They discovered that for many elements the product of the element's atomic weight and specific heat is a constant—with an average value at room temperature of 6.2 calories per gram atom. This finding, known as the Dulong-Petit law, was subsequently used by them and others to determine the atomic weights of some elements.

Duluth [duh-looth'] Duluth (1990 pop., 85,493), the third largest city in Minnesota, is an international seaport located at the western end of Lake Superior, opposite Superior, Wis. The seat of St. Louis County, it is an important shipping, commercial, and manufacturing center. The Duluth-Superior harbor, which is icebound about four months of the year, is situated at the head of navigation on the Great Lakes. It is the second largest of the Great Lake ports and one of the country's major grain-shipping centers. The city is long and narrow, built along rock bluffs that rise 180–240 m (600–800 ft) above the harbor. It extends about 40 km (25 mi) along the lake shore.

The site was inhabited by Chippewa (OJIBWA) Indians when explorers—including Daniel Greysolon, sieur Deluth, for whom the city is named—arrived in the 1670s. Although long a fur-trading post, it was not permanently settled until 1852. Growth was spurred by the opening (1855) of the Sault Ste. Marie Canal connecting Lakes Huron and Superior and by the discovery of mineral deposits to the north in the Mesabi Range.

Duluth, Daniel Greysolon, Sieur [due-luet', dahn-yel' gray-soh-lohn', sur] Daniel Greysolon, sieur Duluth, b. *c.*1639, d. Feb. 25, 1710, was a French explorer in the Great Lakes region. He arrived (1675) in Canada after more than 17 years of military service in Europe. From 1678 to 1688 he explored and traded in the Lake Superior region, establishing French authority in the area. He befriended the Indian tribes, reconciling their differences wherever possible, disciplining them, and dissuading them from trading at the Hudson's Bay Company posts. Through his explorations, which took him as far as northern Minnesota, Duluth increased geographical knowledge, won commerce for France, and gained useful military allies among the Indians. As an officer engaged in trade, Duluth was denounced by the intendants of New France for using military expansion for personal gain, but he was defended by the governors for his other services. He died in retirement in Montreal. Duluth, Minn., is named for him.

Duma [doo'-mah] Duma, from the Russian *dumat',* "to think," was the name of the popularly elected lower chamber mandated by Emperor Nicholas II following the Russian Revolution of 1905. There were four Dumas between 1906 and 1917, the first two of which had majorities hostile to the government. Upon dissolution of the Duma in 1907, the imperial minister Pyotr Arkadievich Stolypin unconstitutionally promulgated new electoral laws to assure a more conservative composition. Even so, the centrist Octobrist party, which dominated the third Duma (1907–12), proved to be less compliant than the government wished, and the fourth Duma produced a Progressive Bloc that led to intense conflict with the government. In the end, the Duma failed to produce an enduring constitutional system in Russia because the government ministers remained responsible to the tsar, and the Duma lacked financial leverage.

Dumas, Alexandre (1802–70) [due-mah'] The lasting fame of French writer Alexandre Dumas, known as Dumas *père*, b. July 24, 1802, d. Dec. 5, 1870, is assured by such historical novels as The Three Musketeers and The Count of Monte Cristo. Paradoxically, he exerted his greatest influence through his early plays, key works in the definition of French romanticism.

Dumas was the grandson of a French nobleman who settled in Santo Domingo and a West Indian woman. His father, a general fallen out of favor with Napoleon, left the family in financial difficulty at his death in 1806. Young Dumas's education was rudimentary. He began clerking in 1818 and eventually worked for the duke of Orléans, who later became King Louis Philippe.

During the 1820s, Dumas, like so many budding romantics, fell under the spell cast by the plays of Shakespeare and the novels of Sir Walter Scott, which influence can be seen in *Henri III et sa cour* (Henry III and His Court, 1829), the first romantic melodrama produced by La Comédie Française. For *Antony* (1831; Eng. trans., 1880), Dumas used a contemporary setting and situation. His ability to create suspense is seen in *La Tour de Nesle* (1832; Eng. trans., 1846).

With the publication of *The Three Musketeers* (1844; Eng. trans., 1846) Dumas embarked on a novel cycle that covered nearly 50 years of 17th-century French history. The cycle included *Twenty Years After* (1845; Eng. trans., 1846) and the story "The Man in the Iron Mask" from *Le Vicomte de Bragelonne* (1848–50; Eng. trans., 1851). *The Count of Monte Cristo* (1844–45; Eng. trans., 1846) dealt with the Napoleonic period. The Valois novels (1845–48) explored the 16th century. Dumas's extravagant tastes forced his hectic writing pace: his frequent use of collaborators inspired controversy as to the extent of Dumas's authorship, but recent scholarship has authenticated his contributions. If his boast of having written 1,200 volumes is a gross exaggeration, an edition of his complete works containing 301 volumes (published and edited by Michel Lévy, 1862–89) is irrefutable proof of his unflagging energy. That energy animated his journalistic enterprises, his extensive travels, and his adventures, including participation in Garibaldi's campaign in Sicily in 1860. Scandals and financial vicissitudes plagued his last years. He died in the home of his illegitimate son, the playwright and novelist Alexandre Dumas.

Dumas, Alexandre (1824–95) The French author Alexandre Dumas, known as Dumas *fils,* b. July 27, 1824, d. Nov. 27, 1895, was the illegitimate son of Alexandre Dumas *père*. Like his illustrious father, he wrote novels and plays, establishing the genre known as the problem, or thesis, play.

Dumas's most famous work is *La Dame aux camélias,* known in English as Camille, which appeared both as a

Alexandre Dumas, a prolific French author of the 19th century, achieved fame with such historical adventure novels as The Three Musketeers, The Count of Monte Cristo, *and* The Man in the Iron Mask.

novel (1848; Eng. trans., 1931) and as a play (1852; Eng. trans., 1956). The theatrical version became famous, serving as a vehicle for such actresses as Sarah Bernhardt, Edwige Feuillère, and Greta Garbo; it also inspired Verdi's opera *La Traviata*. Another of his widely popular plays, *Le Demi-Monde* (1855; Eng. trans., 1858; trans. as *The Outer Edge of Society*, 1921), deals with the same milieu as that of *Camille*.

In his choice of subjects, Dumas *fils* pointed the way toward the naturalism of such authors as Émile Zola. His father's tastes and abilities favored the historical novel and the adventure tale, but Dumas *fils* preferred to write of contemporary society. Although vestiges of romanticism can be noted in his works, Dumas *fils* attempted to analyze the social ills of his times. His other novels and plays include *Tristan le Roux* (1850) and *L'Affaire Clemenceau* (1866). He was admitted to the Académie Française in 1875.

Dumas, Henry Henry L. Dumas, b. Sweet Home, Ark., July 20, 1934, d. May 23, 1968, was an accomplished American poet and short-story writer. His career ended suddenly when he was shot in Harlem by a police officer in a case of mistaken identity. Three volumes of his work have appeared posthumously: two books of poems, *Poetry for My People* (1970) and *Play Ebony, Play Ivory* (1974); and a volume of stories, *Art of Bones* (1970). His poetry and his stories deal with African Americans in the rural South and the urban North and draw imaginatively on African sources.

Dumbarton Oaks [duhm-bar'-tuhn] Dumbarton Oaks in Washington, D.C., was the site of the August–October 1944 conference of American, British, Soviet, and Chinese representatives that laid the basis for later discussions leading to the foundation of the UNITED NATIONS.

Mildred and Robert Woods Bliss gave Dumbarton Oaks, their home in the Georgetown area of the city, to Harvard University in 1940, along with their collection of Byzantine, early Christian, and medieval books and objects of art. It became a major center of study and research. It has an important collection of pre-Columbian art and sculpture; 4.8 ha (12 acres) of formal gardens are open to the public.

dumdum bullet The dumdum was one of the first expanding bullets. Because its metal jacket was left open at the tip, the bullet flattened on impact, thus causing much greater internal damage than that produced by an ordinary bullet. It was devised by the British in the 1890s at the Dum-Dum arsenal in India, using a standard British Service bullet with its jacket trimmed back at the nose. Used to stop the charges of "fanatical tribesmen" in India and at the Battle of Omdurman (1898) in the Sudan, the dumdum inspired international outrage, and in 1899 the first HAGUE CONFERENCE outlawed its use in war. Currently, expanding bullets form part of the armament of many U.S. police departments.

Dumfries and Galloway [duhm-frees', gal'-oh-way] Dumfries and Galloway (1988 est. pop., 147,500) is an administrative region in southwestern Scotland covering 6,371 km^2 (2,460 mi^2). Except for the rocky coastline along the Irish Sea and narrow coastal plain, the region is mountainous, reaching 842 m (2,764 ft) at Merrick. Agriculture is the principal economic activity, and dairy cattle and sheep are raised. Resorts are located along the coast, and light industry is found primarily in the towns of Dumfries, Kirkcudbright, and Stanraer.

Dumfries and Galloway was created in 1975, from the former counties of KIRKCUDBRIGHT, WIGTOWN, and Dumfries.

Dumouriez, Charles François du Perier [due-moo-ree-ay'] Charles Dumouriez, b. Jan. 25, 1739, d. Mar. 14, 1823, was a French general who saved revolutionary France by driving back an invading Prussian army at the Battle of Valmy (Sept. 20, 1792). Following army service under the monarchy, he joined in the French Revolution and became (March 1792) foreign minister in the GIRONDIST ministry. After the onset of the FRENCH REVOLUTIONARY WARS, Dumouriez took over (August 1792) the army in the north and, after Valmy, defeated the Austrians at Jemappes on November 6. He invaded the Netherlands in February 1793 but then arranged an armistice with the Austrians. Abandoned by his troops, he fled to the enemy in April 1793 and eventually retired to England. His treachery helped ruin the Girondists.

Dún Laoghaire [doon lair'-uh] Dún Laoghaire (also called Dunleary; formerly Kingstown) is a borough in eastern Ireland in southeastern County Dublin. It is about 11 km (7 mi) southeast of Dublin on Dublin Bay and has a population of 54,715 (1986). An important fishery and a popular yachting harbor, Dún Laoghaire (Irish Gaelic for "fort of King Leary") is the terminal for a car ferry from Holyhead, Wales. The town is often identified with the author James Joyce, who lived (1904) in a martello tower on the shore of the bay. The tower now houses the Joyce Museum.

Dunant, Jean Henri [due-nahn'] Jean Henri Dunant, b. Geneva, May 8, 1828, d. Oct. 30, 1910, founded the RED CROSS. Disturbed by the lack of care for the wounded during the Battle of Solferino in 1859, Dunant published an appeal for the formation of volunteer groups devoted to the relief of suffering caused by war and natural disasters. This led to the organization of the first Red Cross societies in 1864. For his Red Cross work, and for his efforts on behalf of disarmament, Dunant was cowinner of the first Nobel Peace Prize in 1901.

Dunaway, Faye Faye Dunaway, stage name of Dorothy Faye, b. Bascom, Fla., Jan. 14, 1941, attained film stardom in *Bonnie and Clyde* (1967). Her reputation remained undiminished through her lead roles in such movies as *The Thomas Crown Affair* (1968), *Chinatown* (1974), *Three Days of the Condor* (1975), *Network* (1976; Academy Award, best actress), *Mommie Dearest* (1981), *Barfly* (1988), and *The Handmaid's Tale* (1990). Dunaway also appears on the stage and in television films.

Dunbar, Paul Laurence Paul Laurence Dunbar, b. June 27, 1872, d. Feb. 9, 1906, was an Ohio-born poet and novelist and the son of a slave. He was extremely popular for his folksy and perhaps overly idyllic poems about slave life on Southern plantations. His poetry includes *Lyrics of Lowly Life* (1896), *Lyrics of the Hearthside* (1899), and *Lyrics of Love and Laughter* (1903).

Dunbar, William William Dunbar, *c.*1460–*c.*1521, was a Scottish poet of the late Middle Ages. His poems show agility in handling a variety of meters and diction ranging from the highly ornate to the vulgar and scurrilous, as well as skillful use of medieval poetic conventions.

Dunbar intended most of his poems to be read aloud or recited at court. *The Thistle and the Rose* (1503) and *The Golden Targe* (1508) are allegories containing sparkling description and elaborate, aureate diction. The allegory *The Dance of the Seven Deadly Sins* (1503–08) uses conventional figures to create a grimly comic effect. Dunbar's religious lyrics, especially *A Ballad of Our Lady*, demonstrate a joyful energy, elaborate meter and rhyme, and a suggestive use of Latin. Satires such as *The Treatise of the Two Married Women and the Widow* (*c.*1508) combine a lively description of ordinary life with a juxtaposition of courtly and common diction. The meditative poem *Lament for the Makaris* (*c.*1508) treats the somber themes of old age, mutability, and death in the tradition of François Villon. The *Flyting of Dunbar and Kennedie*, a mock battle of words between two poets, combines alliteration and rhyme with a variety of abusive language.

Dunbarton Dunbarton (also called Dumbarton) was a county in western Scotland until 1975, when it became part of the STRATHCLYDE administrative region. Dumbarton was the county town. Grain, root, and fodder crops are grown in the fertile river valleys, and sheep and dairy cattle are raised at higher elevations. Tourism is significant because of Dunbarton's mountains and glacial lakes, including Loch Lomond. Industry is centered at Clydebank. Parts of the Antonine Wall, built by the Romans in AD 140, remain in the region. In the 5th century, the area became part of the kingdom of Strathclyde, and in the 12th century, it was included in the earldom of Lennox.

Duncan, Isadora Isadora (Dora Angela) Duncan, b. San Francisco, May 26, 1877, d. Sept. 14, 1927, was a pioneer of MODERN DANCE. With little formal training, she rejected the restraints of ballet technique and costuming and devised her own free style based on natural movement and performed barefoot in loose, flowing tunics. She first crossed the Atlantic with Augustin Daly's theater company for a tour of Britain in 1897. In 1899 she made her second visit, and dancing to classical concert music, she received wide acclaim. Duncan first visited Greece in 1903 and Russia in 1904, where she influenced Serge Diaghilev and Mikhail Fokine in their plans for ballet reform.

The freedom of her dances was matched in her personal life, especially in her tempestuous love affairs with the stage designer Gordon Craig and the millionaire Paris Singer. In 1921 she visited the Soviet Union and married the peasant poet Sergei Essenin, who left her in 1923 and committed suicide in 1925. By then Duncan had returned to France, where she gave her last performance in Paris in July 1927. In Nice, in September of that year, she was strangled instantly when her scarf caught in the wheel of her sports car.

Isadora Duncan's expressive dance style influenced the wave of interpretive movement that came to be known as modern dance.

Duncan, Robert Robert Edward Duncan, b. Oakland, Calif., Jan. 7, 1919, d. Feb. 3, 1988, a highly influential poet, was a leading member of the BLACK MOUNTAIN SCHOOL OF POETRY. Duncan reached the height of his powers with the volumes *The Opening of the Field* (1960), *Roots and Branches* (1964), and *Bending the Bow* (1968)—wherein the verse is somewhat hermetic because of its incantatory qualities. His last volume of poetry was entitled *Ground Work II: In the Dark* (1987). Duncan was also a teacher, critic, and small-press editor.

Dunciad, The A mock-heroic or mock-epic poem comprising four books written by Alexander POPE, *The*

Dunciad (1743) is often considered Pope's finest achievement. Written in heroic couplets, the 1,770-line satire makes use of the great epics of the past—those of Homer, Vergil, Milton—in narrating the ascension of the goddess of Dulness and her newly anointed prince of Dulness, Colley Cibber, to reign over the realm of all humane and intellectual pursuits. The pervasive force of Dulness, seen to reside in the corrupted mind of man, infests the world of learning and imagination to such a degree that *The Dunciad*'s final vision is of annihilation and chaos: "And Universal Darkness buries All."

Dundee [duhn-dee'] Dundee is a city in Tayside Region, eastern Scotland. It is located on the Dundee Law (a hill 174 m/571 ft high) on the north shore of the Firth of Tay about 64 km (40 mi) northeast of Edinburgh. Its population of 175,700 (1987 est.) makes it Scotland's third largest city. A seaport, it is also a commercial and manufacturing center. Textiles, electronic goods, tires, and carpets are its most important products. It is the site of the 3-km-long (2-mi) Tay railroad bridge (completed 1888) and the Tay road bridge (completed 1966). It is also the seat of the University of Dundee (founded as Queen's College, 1881). The city dates from pre-Roman times. In the 9th century it was the center of power for Kenneth I, the first Scottish king.

Dundee, John Graham of Claverhouse, 1st Viscount [klav'-ur-uhs] John Graham of Claverhouse, b. 1649?, was a Scottish Jacobite general known as "Bonnie Dundee." He defeated William III's forces at Killiecrankie, Scotland, on July 17, 1689. Dundee, killed in the battle, is the subject of many stories and ballads, including Sir Walter Scott's song "Bonnie Dundee."

dune see SAND DUNE

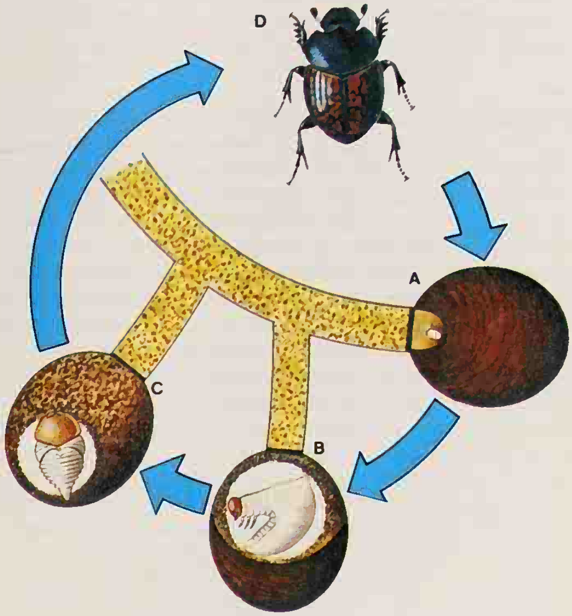
Dunedin [duh-nee'-din] Dunedin is the principal city of the Coastal–North Otago district on the southeastern shore of South Island, New Zealand. The second largest city of South Island, it has a population of 106,600 (1988 est.). Significant industry, including wool processing, has developed, and port facilities are at Port Chalmers, 13 km (8 mi) to the northeast.

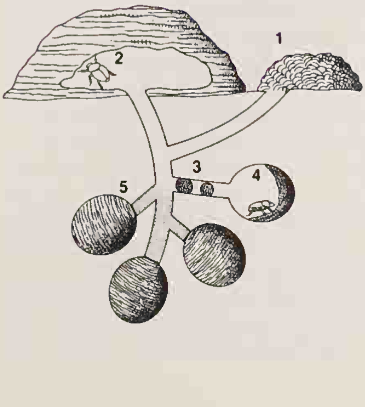
Founded in 1848 by Scottish Presbyterians, Dunedin was a prominent port during the late 19th century, partially due to the discovery of gold in the area in the 1860s. The University of Otago (1869), New Zealand's oldest university, is there.

Dunfermline [duhn-furm'-lin] Dunfermline is a city in Fife County near the eastern coast of Scotland about 19 km (12 mi) northwest of Edinburgh. Its population is 52,057 (1981). Since the establishment of a branch of the British Linen Company there in 1718, it has been the center of the Scottish linen industry. Other industries include coal and metals. Dunfermline was, from the 11th century, a residence of the Scottish monarchs. The Abbey Church, parts of which date from the 12th century, is a shrine containing the grave of Robert I. Other Scottish kings of the 11th to the 17th centuries are also buried there. Dunfermline was the birthplace of philanthropist and industrialist Andrew Carnegie and is headquarters of the Carnegie Trusts.

dung beetle Dung beetle is the common name for stout beetles varying in length from 0.5 to 3.0 cm (0.2 to 1.2 in) and belonging to the family Scarabaeidae. They dig holes and tunnels near piles of dung and bury several times their weight in dung as a food supply. They eat

The life cycle of a dung beetle begins when an egg (A) *hatches and the larva* (B) *eats the available dung. As a pupa* (C), *it fills the chamber with its waste. An adult beetle* (D) *emerges aboveground.*





(Left) *Dung beetles of the genus* Onthophagus *dig brood chambers beneath a pile of cow manure and dump excavated soil aboveground* (1). *The male digs cow dung* (2) *and passes it as pellets* (3) *to the female, who fills the chamber with pellets* (4), *lays her egg, seals the chamber, and then fills the gallery with sand* (5).

continuously, consuming more than their weight daily, then surface for a fresh supply. In the tropics, dung beetles can propel balls of dung as large as an apple. The ancient Egyptians regarded the sacred scarab beetle, *Scarabaeus sacer*, as holy.

Dunham, Katherine Katherine Dunham, b. Chicago, June 22, 1912, is an American dancer and choreographer. She earned a doctorate in anthropology, and her research in Afro-American dance, particularly in the West Indies, inspired works based on ethnic forms and on popular dances of the time. Dunham gave her first New York City concert and also appeared in the Broadway musical *Cabin in the Sky* in 1940. Her African-American revues toured the United States and Europe in the 1940s and '50s. From 1945 to 1955, Dunham maintained a school of dance in New York City. In the late 1960s she established and became the director of Southern Illinois University's Performing Arts Training Center in East St. Louis, Ill. Later she established her own dance school and museum there. In the 1980s, Dunham worked with Alvin Ailey to revive some of her ballets of the 1940s.

Dunhuang (Tun-huang) [doon-hwang] The Chinese oasis town of Dunhuang, in the extreme northwest of Gkansu province, was the ancient entryway to China for merchants and Buddhist missionaries traveling the SILK ROAD across central Asia. It was fortified by the Chinese in the Han period (202 BC–AD 220) and flourished as a trading center until the mid-8th century, when it fell under Tibetan rule and the caravan route shifted northward. Dunhuang was a major Buddhist monastic and pilgrimage site, known for its Caves of the Thousand Buddhas (Qianfodong), a series of richly ornamented rock-cut sanctuaries whose construction began in the 4th century. A valuable collection of Buddhist objects enclosed since the 11th century was discovered (1907–08) among the caves by Sir Aurel Stein. The finds included painted silk banners, sculptures, and a large library of Buddhist and secular manuscripts, many of which are now in the Musée Guimet, Paris, and the British Museum, London.

dunite [doo'-nyt] Dunite is a granular, green variety of an IGNEOUS ROCK called PERIDOTITE. Composed of coarse grains of OLIVINE, it is sometimes rich in CHROMITE and is the source of the world's supply of CHROMIUM. It weathers to a dun brown color, as at Mount Dun, in New Zealand, its namesake. Intrusions of dunite form sills or dikes. Some dunite has been altered to form SERPENTINE.

Duniway, Abigail Scott Abigail Scott Duniway, b. near Groveland, Ill., Oct. 22, 1834, d. Oct. 11, 1915, was a leader of the women's rights movement in the northwestern United States. After migrating to the Oregon Territory, she taught, ran a small store, and wrote extensively. She also acted as publisher of the weekly *New Northwest* (1871–87), lecturer throughout the Pacific Northwest, and a founder (1873) of the Oregon Equal Suffrage Association. Her autobiography, *Path Breaking*, appeared in 1914.

Dunkerque [duen-kerk'] Dunkerque (English: Dunkirk) is a port city on the North Sea coast of France, 11 km (7 mi) from the Belgian border. Its population is 73,120 (1982). Located on the eastern end of the Strait of Dover, the city is an industrial center with shipyards and oil refineries; fishing is also important. The beach resort Malo-les-Bains is nearby.

Founded before the 19th century, the city, whose name is derived from the Flemish for "Church of the Dunes," was the object of conflicts among England, France, Spain, and Holland during the 16th and 17th centuries. !t was held by the English after the 1658 Battle of the Dunes and was sold to France in 1662. It was a favorite port for 17th-century pirates. During World War II, Dunkerque was the site of the massive evacuation of about 350,000 British, French, and Belgian soldiers by a fleet of military, commercial, and pleasure craft in the face of the German onslaught (May–June 1940). The city was occupied by the Germans until May 1945.

Dunkers see BRETHREN

Dunkirk see DUNKERQUE

Dunlap, William William Dunlap, b. Perth Amboy, N.J., Feb. 19, 1766, d. Sept. 28, 1839, was a dominant force in the American theater during the years 1790–1810. An artist, playwright, producer, manager, and historian, he wrote and adapted more than 50 plays. These include *The Father* (1789), a comedy that immediately became a hit; *André*; (1798), a verse tragedy based on the American Revolution, which he reworked into the popular *The Glory of Columbia* (1803); and immensely successful adaptations of sentimental foreign dramas.

Dunlap was also a painter and a founder of the National Academy of Design. In 1796 he entered theatrical management, becoming sole manager of the Old American Company and of the Park Theatre in New York from 1798 until its bankruptcy in 1805. His other writings include *A History of the American Theatre* (1832) and a biography of George Frederick Cooke.

Dunlop, John John Boyd Dunlop, b. Feb. 5, 1840, d. Oct. 23, 1921, was a Scottish veterinary surgeon who manufactured the first pneumatic TIRES. In 1888, Dunlop fitted his son's tricycle with inflated sheet-rubber tubes covered with canvas. He soon began making similar tires for bicycles. Once Britain's restrictive automobile laws were repealed, cars were also fitted with them. Dunlop helped form Dublin's Pneumatic Tyre Company (1889), retiring from its board (1895) seven years before the firm was renamed for him.

Dunmore, John Murray, 4th Earl of Lord Dunmore, b. 1730, d. Feb. 25, 1809, was the last British governor of Virginia (1771–75). He opened up the Ohio Valley for settlement by defeating the Shawnee in Lord Dunmore's War (1774). Continually in conflict with the colonial assembly, he was forced to take refuge on a British warship when the American Revolution broke out in 1775. He returned to England in July 1776.

Dunois, Jean, Comte de [duen-wah', zhawn, kohnt] Jean, comte de Dunois, b. 1403, d. Nov. 24, 1468, also known as the Bastard of Orléans, was an important military commander in the service of Charles VII of France during the late stages of the Hundred Years' War. An illegitimate son of Louis, duc d'Orléans (see Orléans family), he was the nephew of Charles VI and the uncle of Louis XII. He is best known for having served with Joan of Arc in relieving besieged Orléans in 1429, but he fought in many campaigns as a royal commander or brigand chief. He twice joined princely rebellions (1440, 1464–65) but regained royal favor after each of them.

Duns Scotus, John [duhnz skoh'-tuhs] A Scottish philosopher and theologian called the Subtle Doctor, John Duns Scotus, b. *c.*1265, d. Nov. 8, 1308, was one of the most influential thinkers of medieval scholasticism. He became a master of theology at Paris in 1305 and lectured there until he was assigned to Cologne in 1307, where he died the following year.

Scotus's most important work, known as the *Ordinatio* or *Opus Oxoniense*, is a definitive version of his various commentaries on the *Sentences* of Peter Lombard. Philosophically, he relied heavily on Plato and Avicenna. Instead of the necessary emanation of all things from God as postulated by Avicenna, Scotus insisted on the absolute primacy of God's free will, a position called voluntarism. His philosophy is notable for its subtlety and multiplicity of distinctions and formalities. In theology Scotus is best known for his defense of the Immaculate Conception of the Virgin Mary. Scotism is a principal school of Roman Catholic thought.

Dunsany, Lord [duhn-san'-ee] Edward John Moreton Drax Plunkett, 18th Baron Dunsany, b. July 24, 1878, d. Oct. 25, 1957, was an English-born Irish writer once popular for his fantasy-filled symbolic plays and stories written in a highly refined, sardonic style all his own. His short verse plays include *The Glittering Gate* (1909), *The Gods of the Mountain* (1911), and *The Lost Silk Hat* (1914). He also wrote collections of prose tales, such as *The Gods of Pegana* (1905) and *A Dreamer's Tales* (1910), and the autobiographical *Patches of Sunlight* (1938).

Dunstan, Saint Saint Dunstan, b. *c.*909, d. May 19, 988, was an English monk and archbishop of Canterbury. As abbot of the monastery of Glastonbury from *c.*943, he made it a famous center of learning. Dunstan became successively bishop of Worcester, bishop of London, and archbishop of Canterbury (960). Together with King Edgar, he implemented a national program of ecclesiastical reform and political unification. Dunstan was also a renowned metalworker, illuminator, and musician.

duodecimal system [doo-oh-des'-i-muhl] A duodecimal number is a number written in base 12. An advantage of base 12 is that certain numerical computations become easier. For example, ½, ⅓, ¼, ⅙, and ⅑ all have finite duodecimal expansions. To express numbers in a duodecimal system, 12 digits are needed, say T for 10 (base 10) and E for 11 (base 10). Thus, a duodecimal integer would look like 3E04T. In base 10, this would equal $(3 \times 12^4) + (11 \times 12^3) + (0 \times 12^2) + (4 \times 12^1) + (10 \times 12^0) = 81{,}274$.

duodenum [due-uh-dee'-nuhm] In mammals, the duodenum is the portion of the small intestine between the stomach and the jejunum, or middle portion of the small intestine. It serves to digest further the food passed from the stomach; it also, like the rest of the small intestine, absorbs food through its lining into the bloodstream and lymphatic system (see digestion, human). Passage of food into the duodenum is regulated by the pyloric sphincter, a ring of muscle. The bile duct carries bile from the liver and gallbladder to aid in fat emulsification and nutrient absorption. The pancreatic duct carries enzymes from the pancreas for protein, starch, and fat digestion. The wall of the duodenum consists of four layers. The innermost, the mucosa, is an absorptive surface lined with fingerlike projections (villi). The other layers are those of connective tissue (submucosa), muscle, and thin membrane (serosa).

Dupleix, Joseph François [due-pleks'] Joseph François Dupleix, b. Jan. 1, 1697, d. Nov. 10, 1763, was a French administrator in India. A member of the superior council of the French East India Company at Pondichéry (Pondicherry), India, from 1721, Dupleix became (1731) governor of Chandernagor and from 1742 to 1754 was governor-general of the company at Pondichéry. During the War of the Austrian Succession, he captured (1746) Madras from the English and successfully defended (1748) Pondichéry against English siege. Dupleix hoped to establish a French empire in southern India but was constantly thwarted by the successes of his English rival Robert Clive and received scant support from the company directors in France. Dupleix was recalled to France in 1754, but neither the government nor the company would reimburse him for the fortune he spent for them in India. He instituted two principles in India that the British used later in their administration: establishing indirect rule through alliances with the Indian princes and training native troops effectively.

Duplessis, Maurice Le Noblet [due-ples-ee'] Maurice Le Noblet Duplessis, b. Trois Rivières, Quebec, Apr. 20, 1890, d. Sept. 7, 1959, was premier of Quebec (1936–39, 1944–59). A lawyer, he was elected (1927) to the Quebec Assembly as a Conservative. In 1936, however, he formed the Union Nationale party and led it to electoral victory. Duplessis was an authoritarian premier. He worked closely with business interests and the Roman Catholic church, and he championed provincial rights.

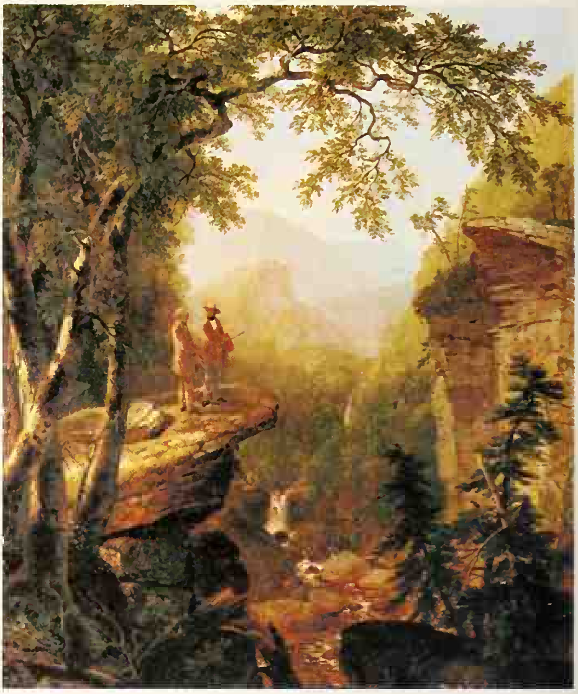
Duquesne, Fort see FORT DUQUESNE

Dura-Europus [door'-ah-yu-roh'-pahs] Dura-Europus (Doura-Europos), an ancient city on the Euphrates River in Syria, was founded (*c*.300 BC) by the Seleucids. Originally known by its Greek name, Europus, it was called Dura after its capture (*c*.100 BC) by the Parthians. Under Parthian rule it prospered as a center of agriculture and the caravan trade. In AD 165 the city was taken by the Romans and incorporated into the province of Syria. After its siege and destruction by the Sassanians (*c*.257), Dura-Europus was completely abandoned.

Excavations carried out after the discovery of the site in 1921 have yielded rich evidence of the daily life of this Greco-Mesopotamian city during the Hellenistic and Roman periods. Though Greek influence remained strong, by the 1st century BC the mixed Greek-Iranian-Semitic population lived in Oriental houses, wore Oriental clothing, worshiped Oriental gods, and decorated their homes and places of worship with brilliant frescoes in a strongly Orientalized style. Among the most important discoveries at Dura-Europus were a very early (3d-century) Christian church and a synagogue of the same period. The murals from the synagogue are major examples of ancient Jewish art.

Durán, Roberto The Panamanian boxer Roberto Durán Samaniego, b. June 16, 1951, is considered one of the greatest lightweights ever. During his career, which began in 1967, Durán held championships in three different weight divisions: lightweight (1972–78), welterweight (1980), and junior middleweight (1983–84). Durable, a powerful puncher, and an intelligent tactician, Durán retired in 1984 with 76 wins and 6 losses; he later returned to the ring with reduced effectiveness.

Durand, Asher Brown Asher Brown Durand, b. Jefferson Village (now Maplewood), N.J., Aug. 21, 1796, d. Sept. 17, 1886, became the leading exponent of the HUDSON RIVER SCHOOL of landscape painting after the death of Thomas Cole. He began as an engraver, but Cole, whom he met in 1837, urged him to concentrate on painting. In his early landscapes Durand rendered every detail with an engraver's precision, but his later works exhibit somewhat freer handling. The traditionally tree-framed, mountainous vistas in his paintings emulated Cole's evocations of America's awesome wilderness.



Asher B. Durand's Kindred Spirits *(1849) portrays the artist's mentor, Thomas Cole* (right), *with the poet William Cullen Bryant* (left) *in a glen in the Catskills. (New York Public Library.)*

One of the first American artists to paint landscape scenes out of doors, Durand gave special attention to the rendering of light. In *Monument Mountain in the Berkshires* (1850s; Detroit Institute of Arts) the range of bluish tones making the stony stream recede beyond the oak to the mountain creates an atmosphere that harmonizes the various elements. He used the light to convey a sentiment similar to essayist Ralph Waldo Emerson's transcendental belief that nature discloses God's grand design. For his *Study from Nature, Rocks and Trees* (*c*.1855; New-York Historical Society) Durand's close vantage point serves to emphasize his detailed scrutiny of the particular type of rock. *Kindred Spirits* (1849; New York Public Library), considered his masterpiece, depicts his mentor Cole and the poet William Cullen Bryant sharing the elevating experience of observing nature in the Catskills.

Durango (city in Colorado) Durango (1990 pop., 12,430; elevation, 1,983 m/6,505 ft) is a city in southwestern Colorado, on the Animas River, and the seat of La Plata County. It was founded in 1880 as a mining town, and it now serves as a shipping center for a ranching and agricultural region.

Durango (city in Mexico) Durango (full name, Victoria de Durango) is the capital of Durango state in west central Mexico, located about 400 km (250 mi) north-northeast of Guadalajara. Its population is 258,000 (1980). Durango lies at the convergence of highways to the Pacific, northern, central, and southern parts of Mexico. Durango has glass works, iron foundries, flour mills, cotton and wool factories, and tobacco processing plants. A mountain of iron ore called Cerro del Mercado, the chief source of Mexican iron, is just to the north.

Founded in 1563, Durango (named after the Spanish city) was formerly an important religious and political center. Its nearby thermal springs at Navacoyán and Valparaíso attract tourists. Durango is the home of the Universidad Juárez del Estado de Durango (1856).

Durango (state in Mexico) Durango, a state in north central Mexico, extends from the western edge of Mexico's central plateau into the Sierra Madre Occidental. The state has a population of 1,402,782 (1989 est.) and covers an area of 123,181 km^2 (47,560 mi^2). The city of Durango is the state capital. Livestock raising on the semiarid plateau is the major economic activity. Corn, cotton, wheat, tobacco, sugarcane, and vegetables are grown in the irrigated Río Nazas valley. Gold, silver, coal, iron, and other minerals are mined in the mountains, and metallurgy, textiles, timber, and food processing are the main industries in the towns.

Durango was explored by the Spanish in 1562 and became part of the province of Nueva Viscaya. In 1823, when Mexico became independent, Durango became a state.

Durant, Thomas Clark Thomas Clark Durant, b. Lee, Mass., Feb. 6, 1820, d. Oct. 5, 1885, was the individual chiefly responsible for building the Union Pacific Railroad. In 1863 he was made vice-president of the newly chartered Union Pacific and took over much of the company's management and financing. When Congress increased the privileges of the railroad, Durant organized (1864) the CRÉDIT MOBILIER OF AMERICA to finance it and attracted a group of investors headed by Oakes Ames. Durant lost control of the company to Ames in 1867 but stayed with the railroad and pushed for its completion, which occurred on May 10, 1869.

Durant, Will and Ariel William James Durant, b. North Adams, Mass., Nov. 5, 1885, d. Nov. 7, 1981, was a popular historian who reached a remarkably wide audience. His principal works were *The Story of Philosophy* (1926), a best-seller, and *The Story of Civilization* (1935–75), an 11-volume historical series described as a "biography of mankind." Will's wife, Ariel (Ada Kaufman), b. Russia, May 10 (N.S.), 1898, d. Oct. 25, 1981, coauthored the last five volumes of *The Story of Civilization*. The tenth volume, *Rousseau and Revolution* (1967), won a Pulitzer Prize. Will and Ariel Durant's last book was *A Dual Autobiography* (1977).

Durant, William Crapo William Crapo Durant, b. Boston, Dec. 8, 1861, d. Mar. 18, 1947, was an American businessman who founded the General Motors Corporation. Beginning as a carriage manufacturer, he bought control of the Buick Motor Car Company in 1904 and made it into a leading automobile producer. In 1908 he established General Motors, acquiring the Cadillac, Oakland (later Pontiac), and Oldsmobile companies within the next two years. Durant soon encountered financial difficulties and lost control of General Motors, but he joined with Louis Chevrolet in forming (1911) the Chevrolet Motor Car Company and used the stock of that successful enterprise to buy back into General Motors in 1915. He lost control again in 1920. He organized Durant Motors in 1921, but the new company was unsuccessful and failed in 1933.

Durante, Jimmy [dur-ant'-ee] James Francis Durante, b. New York City, Feb. 10, 1893, d. Jan. 29, 1980, a popular star of nightclubs, musical comedies, radio, films, and television, began his career as a ragtime piano player in Coney Island, N.Y. His trademarks were his large nose ("schnozzola," in Durante's terms) and beat-up hats. Durante excelled at gravel-throated singing and at mangling the English language.

Duras, Marguerite [due-rah'] Marguerite Duras, b. Gia Dinh, Indochina (now Vietnam), Apr. 4, 1914, a French novelist, dramatist, scenario writer, and film director, is associated with the "new wave" of postexistentialists. *The Sea Wall* (1950; Eng. trans., 1952) was her first successful novel. Among her more notable works are *Moderato Cantabile* (1958; Eng. trans., 1960), *The Lover* (1984; Eng. trans., 1985), and *The War: A Memoir* (Eng. trans., 1986), a semiautobiographical piece that Duras claims to have no recollection of writing. Her screenplays include *Hiroshima, Mon Amour* (1959) and *The Vagabond* (1986).

Durban [dur'-buhn] The city of Durban, located on South Africa's east coast in Natal Province, 560 km (350 mi) southeast of Johannesburg, on Durban Bay, is Africa's busiest port. Durban covers an area of 245 km^2 (95 mi^2) and has a population of 982,075 (1985).

Durban was linked by rail with Johannesburg in 1895, making it a port for the mines of the Witwatersrand. Industries, located along the recently modernized harbor, include petroleum refining; textile, footwear, and chemical manufacturing; and food processing. The sugar terminal is the largest in Africa. Durban is South Africa's most popular seaside resort. The city has two universities: Natal (1909) and Durban-Westville (1960).

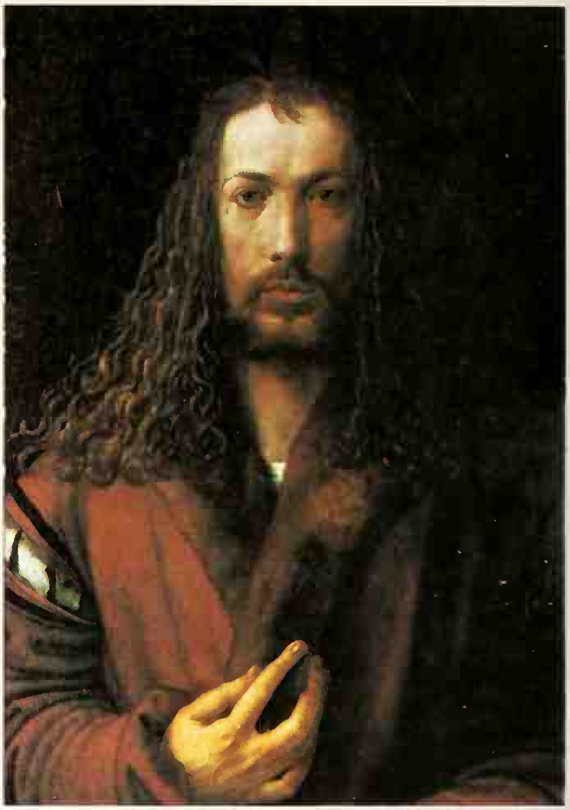
Established as Port Natal in 1824, the city was renamed Durban in 1835 for Sir Benjamin D'Urban, governor of the British Cape Colony.

Dürer, Albrecht [dyur'-ur, ahl'-brekt] Albrecht Dürer, b. May 21, 1471, d. Apr. 6, 1528, was the most important German artist in the period of transition from the late Gothic to the Renaissance. The son of a Nuremberg goldsmith, he made his first trip to Venice in 1494–95 and returned to that city between 1505 and 1507, where he was strongly influenced by Italian Renaissance art. He also became aware of the better social status of artists in Italy. On his return to Germany he developed friendships with such northern humanists as Martin Luther and Desiderius Erasmus. Dürer was appointed court painter to Maximilian I, Holy Roman emperor, in 1512, a position renewed under Charles V in 1520. He developed a fever in Zeeland in 1521 and died from its lingering effects in Nuremberg.

Dürer's greatest accomplishments were in the graphic arts of WOODCUTS AND WOOD ENGRAVINGS. His woodcuts departed from the production of simple linear designs to illustrations of great complexity and pictorial richness. He produced several extensive series of woodcuts, such as those illustrating the *Apocalypse* (1496–98), the events of the passion of Christ in the *Large Passion* (1498–1510) and the *Small Passion* (1509–11), and the *Life of the Virgin* (1501–11). Dürer also developed the art of engraving to an unrivaled level of technical mastery, as is evident in his four Master Prints *Adam and Eve* (1504), the *Knight, Death and the Devil* (1513), *Melancholia* (1514), and *St. Jerome in his Study* (1514). The *Apocalypse* series and other woodcuts produced before his second trip to Italy manifest a tumult and energy of tightly packed, interwoven forms, heightened by flickering accents of light and shadow. In contrast, Dürer's woodcuts and engravings after 1507 reveal a developing sense of balance, ample space, larger forms, and a measured calmness that may be due to an assimilation of similar characteristics from Italian Renaissance art.

Many of Dürer's paintings fall more consistently within the tradition of German painting of the period. A remarkable series of self-portraits, including *Self-Portrait* (1500; Alte Pinakothek, Munich), and such altarpieces as *The Dresden Altarpiece* (1496–1503; Dresden State Art Collections) and the *Paumgärtner Altarpiece* (1503–04; Alte Pinakothek, Munich) are intensely personal creations. His *Adoration of the Magi* (1504; Uffizi Gallery, Florence), however, reveals his knowledge of designs by Leonardo da Vinci for a similar painting. His now damaged *Feast of the Rose Garlands* (1505–06; National Gallery, Prague), with the placement of the Virgin on an elevated, canopied throne in a landscape, reveals the influence of Venetian painting, particularly that of Giovanni Bellini. The panoramic composition of the *Adoration of the Trinity* (1508–11; Kunsthistorisches Museum, Vienna) and the two panels representing the Four Apostles, which the artist presented to the city of Nuremberg in 1526 (Alte Pinakothek, Munich), fuse his personal vision with the monumental impact of Italian painting.

Toward the end of his life Dürer worked on numerous theoretical treatises, including a work on human proportions (1528) and one on the art of fortifications (1527). In addition to his woodcuts, engravings, and paintings, he made many drawings and watercolor studies of landscapes, animals, and people. Many of Dürer's concerns for theoretical matters are to be found in the complex symbolism of his works.



The German artist Albrecht Dürer's Self-Portrait *(1500) reflects his personal intensity and technical genius. Dürer brought the artistic innovations of the Italian Renaissance to Northern Europe. (Alte Pinakothek, Munich.)*

Durga [dur'-gah] In Hinduism, Durga is one form of the mother-goddess Devi, the consort of SHIVA. According to Hindu lore, the gods begged her to find and destroy Mahisasura, a demon who had dethroned them. Mounted on a lion, Durga battled the demon and at last thrust her lance through his heart. In art, she is depicted riding a lion or a tiger.

Durham (city in England) [dur'-uhm] Durham (1982 est. pop., 88,700) is the seat of County Durham, in northeastern England. Situated in an industrial region on the River Wear, only about 24 km (15 mi) south of New-

Albrecht Dürer's Paumgärtner Altarpiece *(1503–04) exemplifies his stylistic development of perspective and proportion. The central panel represents the Nativity; Saint George and Saint Eustace are portrayed on the wings. (Alte Pinakothek, Munich.)*

castle upon Tyne, Durham has continued to be more important as a religious and educational center than as a manufacturing town. Nevertheless, it does produce steel, chemicals, carpets, and organs. Among its cultural institutions is a notable museum of oriental art. Durham Cathedral, begun in 1093 by Bishop William of Calais, is a magnificent example of Norman architecture in England and one of the most notable Romanesque buildings in Europe. Durham's other sites of interest include a castle with portions from Norman times, a monastery established in 1083, and three churches dating from the 12th century. The University of Durham was founded in 1832. Occupied since ancient times, the site became important after William I fortified it in the 11th century to protect southern England from Scottish raids. A pilgrimage site because of the tomb of 7th-century ecclesiastic Saint CUTHBERT in the cathedral, Durham was ruled by prince-bishops for several centuries.

Durham (city in North Carolina) Durham (1990 pop., 136,611) is a city in north central North Carolina and the seat of Durham County. Settled about 1750, the city grew up around the tobacco industry and today produces nearly 20 percent of all U.S. cigarettes. The Duke family, first to mechanize (1881) the tobacco industry, founded the American Tobacco Company there. Other manufactures include textiles, lumber, and precision instruments. Durham is the seat of North Carolina Central University (1909) and of DUKE UNIVERSITY, established (1924) through the philanthropy of the Duke family. The Duke Homestead State Historical Site and a natural history museum are places of interest.

Durham (county in England) Durham is a county in northeastern England, situated on the North Sea coast. The population of Durham is 596,800 (1988 est.), and the county covers an area of 2,437 km^2 (941 mi^2). The city of Durham is the county seat. The eastern portion of Durham is a low-lying plain, gradually increasing in elevation to the west, where the PENNINES reach 747 m (2,452 ft) at Burnhope Seat. Coal mining in the mountains is extensive; stock farming predominates in the river valleys of the Tees and Wear; and mixed agriculture is practiced in the lower eastern region. Iron and steel, chemical, engineering, and shipbuilding industries are located in the larger towns, Consett, Darlington, and Durham.

Durham was on the northern frontier of Roman Britain, and the remains of Roman forts are at Ebchester and Chester-le-Street. In the Anglo-Saxon period it was part of the kingdom of Northumbria and was later frequently the scene of border fighting between the English and Scots.

Durham, John George Lambton, 1st Earl of

John George Lambton, 1st earl of Durham, b. Apr. 12, 1792, d. July 28, 1840, was a British statesman whose parliamentary career earned him the nickname "Radical Jack." Entering the House of Commons as a Whig in 1813, he became a champion of parliamentary reform. He was raised to the peerage as Baron Durham in 1828. Two years later he became lord privy seal and helped draft the great REFORM ACT of 1832. Created Viscount Lambton and earl of Durham on his resignation in 1833, he became the leader of the radical wing of the Whig party. Durham was sent to Canada in 1838 as governor-general after the REBELLIONS OF 1837. Although he remained in Canada for only five months, he published his famous *Report on the Affairs of British North America* (1839), in which he called for the union of Upper and Lower Canada and self-government in local affairs.

John George Lambton, a popular British statesman, served as ambassador to Russia and high commissioner in British North America. Durham's Report on the Affairs of British North America, *presented to Parliament in 1839, advocated colonial reforms for Canada that were eventually adopted throughout the British Empire.*

Durkheim, Émile

[durk'-hime] Émile Durkheim, b. Apr. 15, 1859, d. Nov. 15, 1917, was the major founder of modern sociology as an academic discipline in its own right. He taught education at the University of Bordeaux and in 1902 became professor at the Sorbonne in Paris.

Durkheim's antiutilitarian views (see UTILITARIANISM) led to a concept of society as a moral construct maintained through the development of a common or collective consciousness-conscience (*The Elementary Forms of the Religious Life*, 1912; Eng. trans., 1915). Thus, religion (or a comparable system of beliefs and values) for Durkheim provided the key to the relationship between the individual and society. He dealt with how such beliefs and values can be inculcated in *The Evolution of Educational Thought* (1938; Eng. trans., 1977), with how modern alternatives to traditional social forms can be encouraged to counteract alienation in *Suicide* (1897; Eng. trans., 1951), and with how crime and punishment reflect these socially disturbing processes in *The Division of Labor* (1893; Eng. trans., 1933). Durkheim looked for solutions to such problems to the new field of sociology, which he expected to become an objective science of society and morals.

Much of Durkheim's career was devoted to recruiting and training a body of followers who would publish their research findings in the journal he founded, *L'Année sociologique*. As a result, Durkheim's influence is still deeply felt not only in modern sociology but in anthropology, linguistics, sinology, law, Indology, the classics, religion, and the entire *Annales* school of French historiography.

Durocher, Leo

[dur-oh'-shur] Leo Ernest Durocher, b. West Springfield, Mass., July 27, 1906, d. Oct. 7, 1991, nicknamed "the Lip," was one of American baseball's greatest and most controversial managers. He played for several teams, most notably the New York Yankees (1928–29) and St. Louis Cardinals (1933–37). He began managing of the Brooklyn Dodgers in 1939, and they won the National League title in 1941. In 1948 he became manager of Brooklyn's rival, the New York Giants, who beat the Dodgers in a dramatic playoff for the title in 1951. Durocher's 1954 Giants won four straight games from the Cleveland Indians to take the Series. He was manager of the year in 1939, 1951, and 1954. He also managed the Chicago Cubs and the Houston Astros.

Durrell, Lawrence

[dur'-ul] The novelist, travel writer, and poet Lawrence Durrell, b. Feb. 27, 1912, of Anglo-Irish parents in Jullundur, India, d. Nov. 7, 1990, established his reputation as a compelling and innovative fiction writer with his four Egyptian-set novels constituting *The Alexandria Quartet* (1957–60). After some early experimentation with avant-garde poetry, Durrell published his first serious novel, *The Black Book* (1938), a satire on the shabby inhabitants of a London residential hotel. His World War II service in Egypt and Greece provided background for much of his later fiction and for his travel literature as well, which includes *Prospero's Cell* (1945), *Reflections on a Marine Venus* (1953), *Spirit of Place* (1969), and *The Greek Islands* (1978). *Esprit de Corps* (1957) and *Stiff Upper Lip* (1958) are satires of British diplomatic life. *Collected Poems* appeared in 1980.

Durrell's great tetralogy—*Justine* (1957), *Balthazar* (1958), *Mountolive* (1958), and *Clea* (1960)—was conceived as a relativistic study of modern love, and Durrell vividly captured the decadence, romantic attractions, and drama of prewar and wartime Alexandria with his melting-pot cast of characters. The doublet novels *Tunc* (1968) and *Nunquam* (1970) were not well received, but in the novelist's so-called *Avignon Quintet*—comprising *Monsieur* (1975), *Livia* (1979), *Constance* (1982), *Sebastian* (1984), and *Quinx* (1985)—described as a "quincunx" by Durrell himself, he returned to the power of his place-descriptive prose and the labyrinthine human machinations of the *Quartet*.

Dürrenmatt, Friedrich

[duer'-en-maht] Friedrich Dürrenmatt, b. Jan. 5, 1921, d. Dec. 14, 1990, a Swiss playwright and novelist, is known for his bitter, paradoxi-

The Swiss dramatist Friedrich Dürrenmatt has attracted international interest with his darkly comedic plays about the corrupting influence of power.

cal plays and absurdist themes. Starting as a writer of radio plays and mysteries, he first gained attention outside Switzerland with his existentialist detective novels, *The Judge and His Hangman* (1950; trans. from the German into Eng., 1955) and *The Quarry* (1951; Eng. trans., 1962). His breakthrough as a dramatist came in 1952 with the production of *The Marriage of Mr. Mississippi* (Eng. trans., 1965), a grotesque comedy about two people whose zeal for justice leads them to legitimize murder. *The Visit* (1956; Eng. trans., 1958) centers on the long-delayed and diabolical revenge taken by a rich old woman who had once been victimized. The political dimensions of this world without mercy or hope were portrayed in *The Physicists* (1962; Eng. trans., 1964), which deals with the dangers of scientific knowledge falling into the wrong hands. Dürrenmatt is also known for two short novels, *Traps* (1956; Eng. trans., 1960) and *The Pledge* (1958; Eng. trans., 1960), and for his theater criticism.

Durrës [door'-uhs] Durrës (Italian: Durazzo), a city on the Adriatic coast of Albania, is that country's busiest seaport. Its industries include shipbuilding, flour milling, and the manufacture of foodstuffs, clothing, bricks, and tobacco products. Its population is 78,700 (1987 est.). Founded by Greek colonists in the 7th century BC, Durrës became an important Roman seaport. The old section of the city has mosques, Byzantine towers, medieval fortifications, and several well-preserved Roman arenas.

Duryea, Charles E. and J. Frank [dur'-yay] Charles E. Duryea, b. Canton, Ill., Dec. 15, 1861, d. Sept. 28, 1938, and his brother J. Frank Duryea, b. Washburn, Ill., Oct. 8, 1869, d. Feb. 16, 1967, built (1893) one of the first American automobiles, a horse buggy powered by a one-cylinder gasoline engine. Frank drove a second prototype to victory in the first U.S. automobile race, held in Chicago on Thanksgiving Day, 1895. That same year Charles formed the Duryea Motor Wagon Company, the first U.S. company dedicated to automobile manufacture (see AUTOMOTIVE INDUSTRY). He was among the first to exploit front-end geometry for steering stability. In other respects, however, the Duryea car fell behind automotive evolution, and the firm failed in 1917. By 1900, Frank had set out with his own car company, but this venture was unsuccessful.

Duse, Eleonora [doo'-zuh] The Italian tragedienne Eleonora Duse, b. Vigevano, Italy, Oct. 3, 1858, d. Apr. 21, 1924, was known internationally as one of the greatest actresses of her time. Born into a theatrical family, Duse had her first popular success in Émile Augier's *The House of Fourchambault* (1878; Eng. trans., 1915). In 1893 she scored notable successes in Carlo Goldoni's *La Locandiera* and as Magda in Hermann Sudermann's *Heimatt* (Eng. trans., *Magda*). Her role as Magda, performed in London in 1895 at the same time as Sarah Bernhardt's performance, prompted comparisons of the two actresses.

A restrained actress who "lived" her roles, Duse was capable of subtle and controlled gestures and was able to blush and turn pale at will. She supported and acted in the dramas—*La Gioconda* (1898) and *Francesca da Rimini* (1902)—of Gabriele D'ANNUNZIO, with whom she had a long and tempestuous love affair, recounted in his novel *The Flame of Life* (1900).

Dushanbe [doo-shan-bay'] Dushanbe is the capital of the Tadzhik republic of the USSR. It is situated in the Gissar Valley, between two outliers of the Tian Shan mountain system, on the Varzob River. Dushanbe has a population of 595,000 (1989 est.). The name, meaning "Monday," is derived from the day of the week on which a bazaar was held in the original village on the site. About one-third of all the light manufacturing industries of the Tadzhik republic—producing textiles, apparel, and food products—are concentrated in Dushanbe. A university is also located there. The original village of Dushanbe (then also spelled Dyushambe) was chosen in 1924 as the capital of the new Tadzhik Autonomous Soviet Socialist Republic. In 1929 it became capital of the Tadzhik S.S.R. and was renamed Stalinabad. In 1961, during the de-Stalinization period, the city reassumed its original name.

Düsseldorf [doos'-ul-dorf] Düsseldorf, a city in western Germany, became the capital of the state of North Rhine–Westphalia with the partition of Germany following World War II. Heavily damaged in that war, it is now characterized by modern architecture. The population is 560,600 (1987 est.). Situated on the east bank of the Rhine River 34 km (21 mi) northwest of Cologne, Düsseldorf possesses river ports and extremely active air and rail terminals. It boasts several museums, academies of medicine and the arts, and, since 1965, a university.

Modern Düsseldorf is a product of the Industrial Revolution, although its history as a city dates from the granting of its charter in 1288. It suffered during the Thirty Years' War but later served as capital of Napoleon I's

Grand Duchy of Berg from 1805 to 1813 and then passed to Prussia in 1815.

Major growth began at the close of the 19th century. Stimulated by the proximity of the Ruhr coal and Lorraine iron ore fields, Düsseldorf developed large steel foundries and precision-machine industries. Women's clothing, chemical detergents, and cosmetics are manufactured there, and the city is the European headquarters for many foreign, especially Japanese, firms.

dust, atmospheric Atmospheric dust consists of tiny solid particles (with diameters less than 0.0025 mm/0.0001 in) suspended in the air (see ATMOSPHERE). Natural sources of dust include volcanoes, forest fires, soil erosion, sea spray, bacteria, and plant spores. Artificial sources include many industrial operations and the burning of refuse. Dust can accumulate in areas far from human habitation, as in the Arctic, where concentrations of wind-borne atmospheric soot have been observed. Dust particles serve as nuclei upon which rain droplets and snow crystals can form; in the absence of dust, water-vapor condensation could occur only when the relative humidity greatly exceeded 100 percent. Heavy dust concentrations can lead to various lung diseases (see DISEASES, OCCUPATIONAL; POLLUTION, ENVIRONMENTAL).

Dust Bowl The Dust Bowl is a popular name for the approximately 388,500-km^2 (150,000-mi^2) area that includes the Oklahoma and Texas panhandles and adjacent parts of Colorado, New Mexico, and Kansas. The area is characterized by light soil, a low annual rainfall of 380 mm (15 in), and high winds.

The first white settlers used the region for livestock grazing. Early in the 20th century, however, farmers began to plow up the natural grass cover and plant winter wheat. The area suffered from severe drought between 1934 and 1937 and, without the complex root system of the grasses to anchor it, much of the soil was picked up by the winds. The resulting dust storms and sandstorms were so severe that roads and houses were buried and clouds from the storms were observed hundreds of miles away. More than half the population left the area. The federal government moved to retrieve the land, replanting grass, planting trees, and introducing scientific agricultural methods. As a result, farming became possible again. The Dust Bowl endured other, less severe droughts in the 1950s and '60s. The migration and hardships of the Dust Bowl farmers are described in John Steinbeck's novel *The Grapes of Wrath* (1939).

A region in the southwestern United States known as the Dust Bowl was devastated by dust storms during the 1930s. The parched topsoil was blown by winds into dense clouds called "black blizzards."

dust devil see WHIRLWIND

dust storm see SANDSTORM AND DUST STORM

Dutch art and architecture Dutch art and architecture encompasses those works produced in the Netherlands after the Dutch declared (1581) their independence from Spain. Until the start of the Dutch Revolt in the mid-1560s, the art of the northern provinces of the Low Countries (now the Netherlands) was heavily influenced by the art of the southern, or Flemish and Walloon, provinces (see FLEMISH ART AND ARCHITECTURE). Only in the late 16th and early 17th centuries did a clearly independent artistic tradition emerge in the north. In the course of the 17th century, considered the golden age of Dutch art and architecture, renowned Dutch painters such as Frans HALS, REMBRANDT, and Jan VERMEER executed some of the greatest masterpieces of European art. The art of this period was not only intended for a large segment of society but also reflected in compelling detail the everyday reality that all of society would recognize.

The Late Fifteenth and the Sixteenth Century

Hints of a uniquely Dutch style of painting began to emerge in the late 15th and early 16th centuries. Although some of the best early masters, such as Dirk BOUTS and Gerard DAVID, remained deeply indebted to Flemish art, an indigenous artistic personality was already discernible in the northern schools of Haarlem, Utrecht, and Amsterdam. The most important Haarlem master was Geertgen tot Sint Jans. His specificity of detail and precision of portraiture anticipates later Dutch painting. Another major early Dutch master was Hieronymus BOSCH, whose religious visions of human suffering influenced later-16th-century Flemish artists, in particular Pieter BRUEGEL the Elder.

Many members of the next generation of Dutch artists visited Rome in the 1520s and '30s and returned influenced both by classical motifs and by dynamic, often attenuated and contorted forms characteristic of Italian MANNERISM. At the same time, the burgeoning affluence of Leiden, noted for its prosperous textile industry, attracted several talented artists, especially LUCAS VAN LEYDEN.

The principal centers of late-16th-century Dutch Mannerist painting were the towns of Haarlem and Utrecht. At Haarlem, three artists—the prolific engraver Hendrik Goltzius, Carel van Mander, and Cornelis van Haarlem—formed the first academy for artists in the Netherlands. At Utrecht, Abraham Bloemaert and his many pupils created a broad, flamboyant, highly colorful variant of Mannerism that was tremendously popular and persisted into the early 17th century.

The Golden Age of the Seventeenth Century

The great age of the Netherlands, economically, politically, and culturally, was the 17th century. Although early in this period much of northern Europe was ravaged by the Thirty Years' War (1618–48), the Dutch remained protected by their dikes and their large navy from the devastation and interruptions of war. Amsterdam came to be the financial, shipping, and commodities center for much of western Europe, and artists flocked to the city for commissions. Architecture flourished; fine public buildings and merchant town houses were constructed along the city canals. An atmosphere of religious and intellectual tolerance prevailed in the Netherlands at this time, fostering artistic freedom and experimentation, and a variety of schools and art styles coexisted. Moreover, the principal patrons of art were no longer the church or the aristocracy but the urban merchant class. The Dutch burghers wanted pictures representing the everyday world they knew and the objects their new wealth had allowed them to acquire.

Painting. In the early decades of the 17th century in Haarlem, Frans Hals transformed what had been a minor aspect of earlier Dutch art—the portraits of such groups as militia companies and the directors of corporations or guilds—into a major genre. His large group portraits, showing a dozen or more men arranged dynamically around a table, have a spontaneous quality that captures the vitality of his robust burghers with a broad, detached brushstroke—for the first time, individual strokes were meant to be seen detached from other strokes. The immediacy and baroque (see BAROQUE ART AND ARCHITECTURE) freshness of his highly influential style signaled the end of Mannerist painting in the Netherlands and encouraged a large group of followers, including Hals's brother Dirck, Adriaen van Ostade, and the Flemish peasant painter Adriaen BROUWER.

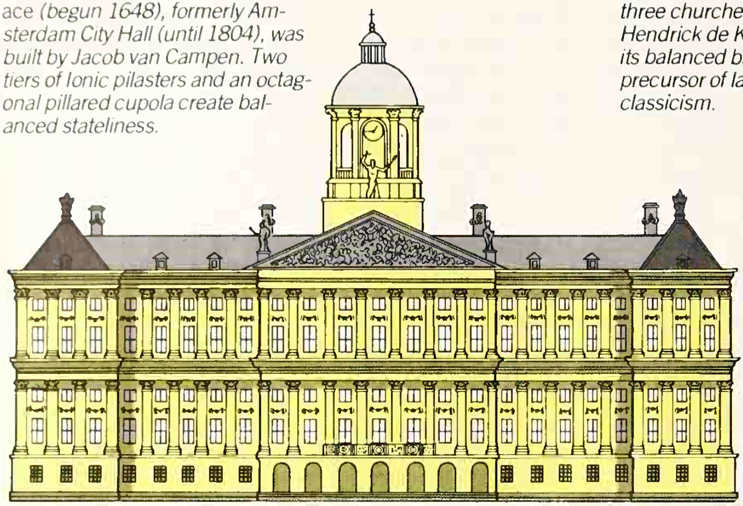
At the same time, a brilliant new style of LANDSCAPE PAINTING was emerging in Haarlem, Leiden, and The Hague. Esaias van de Velde, Salomon van Ruisdael, and especially Jan van GOYEN created in the 1620s a world of identifiable views that also captures the evanescent effects of the high clouds, shifting sunlight, and moisture-laden atmosphere typical of the Dutch countryside. The development of a distinctive school of Dutch marine painting paralleled the evolution of landscape painting, reaching its peak in the period 1645–75. Principal painters of sea pictures include Aelbert CUYP.

Outstanding painters of the Utrecht school, notably Gerrit van HONTHORST and Hendrick TERBRUGGHEN, were powerfully influenced by the spiritually tormented realism and dramatic effects of light and shade of Michelangelo Merisi da CARAVAGGIO and his followers. This tradition also influenced Rembrandt, the towering figure who dominated Dutch painting in the middle third of the 17th century and ranks among the greatest artists of all time. Rembrandt was a protean genius; his 2,000 to 3,000 surviving paintings, prints, and drawings reveal his extraordinary responsiveness to literally everything he saw, from his own face to exotic animals to architecture, cityscapes, and landscapes.

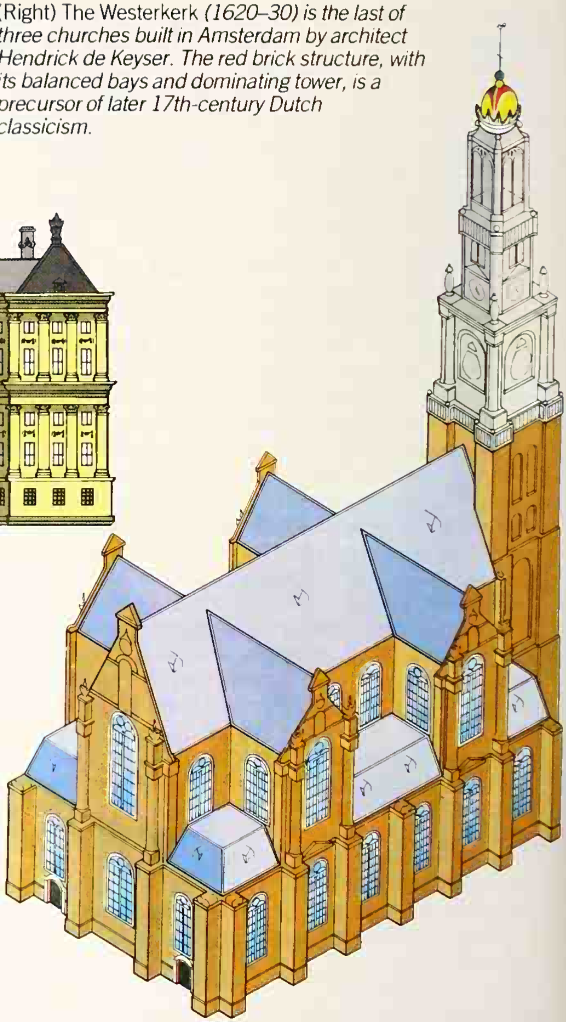
Along with a new monumentality in the depiction of landscape evident in the masterful canvases of Jacob van RUISDAEL, the most important development in the 1660s, the last phase of the golden age of Dutch art, was the vogue for small GENRE PAINTINGS depicting elegant ladies and gentlemen in the courtyards, drawing rooms, and bedrooms of their spacious homes. These dignified views of domestic life reflect the increased wealth of the Netherlands, then the most prosperous and dynamic nation in Europe. The greatest masters of this genre were Pieter de HOOCH, Gerard TER BORCH, and, above all, Jan Vermeer. The central figure of the Delft school, Vermeer concentrated on the world of women with an exquisite refine-

Mother and Child *(c. 1620) by Frans Hals typifies his portraiture and breaking away from the Mannerist tradition. The period witnessed a decline in religious painting, as everyday scenes became more popular. (State Museums, Berlin-Dahlem.)*

The monumental stone Royal Palace *(begun 1648), formerly Amsterdam City Hall (until 1804), was built by Jacob van Campen. Two tiers of Ionic pilasters and an octagonal pillared cupola create balanced stateliness.*



(Right) The Westerkerk *(1620–30) is the last of three churches built in Amsterdam by architect Hendrick de Keyser. The red brick structure, with its balanced bays and dominating tower, is a precursor of later 17th-century Dutch classicism.*



ment and attention to detail.

The Dutch love of intimate domestic culture was also expressed in a tradition of sumptuous STILL-LIFE PAINTING, principally in the depiction of luxurious floral bouquets or arrangements of fruits, tableware, and books. The tradition of flower painting was established as an independent genre by the mid-16th century, but the most beautiful Dutch still lifes were produced in the second half of the 17th century.

Architecture. The most impressive achievement of Dutch architecture prior to the 17th century may more properly be called URBAN PLANNING. Because much of the western Netherlands, as part of the Rhine delta, was originally marshland under sea level, almost every community of any size had to be painstakingly built up and its land reclaimed from the water. In addition to these dike-dam towns, some Dutch communities, such as Leiden, were originally clustered around a fortress on a high point of land and later expanded from this strong point, called the *burcht*, onto reclaimed land.

Although there are fine examples of late Gothic architecture in the Netherlands, especially the Dom Cathedral in Utrecht, an indigenous Dutch style did not develop until the last years of the 16th century. The most important architect of the early 17th century was Lieven de Key; his lively Meat Hall in Haarlem (1602–03) is a colorful mixture of stone quoins and other decoration set against red brick. In the first quarter of the century the skyline of Amsterdam was transformed by the imposing multifaceted church towers of Hendrik de Keyser.

By the mid-17th century, a classical reaction had swept through Dutch architecture. This trend was exemplified in Jacob van Campen's elegant Mauritshuis (*c.*1633; The Hague), for the prince of Orange, with its flat facade and pediment balanced on delicate pilasters. Van Campen's Amsterdam City Hall (begun 1648), now the Royal Palace, was the most important architectural commission of the 17th century in the Netherlands.

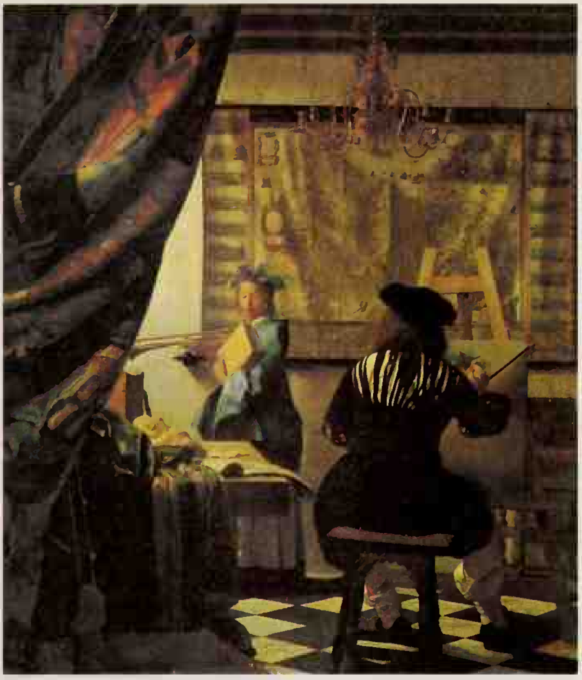
Sculpture and the Minor Arts. Because the western Netherlands was largely marshy and sandy, stone and even wood were scarce, and sculpture was traditionally small in scale and of little importance compared with painting and graphic art. Only in the 17th century did Dutch sculpture become artistically significant, especially in the work of the architect Hendrik de Keyser. De Keyser's major sculptural commission was the tomb of William the Silent (*c.*1618; New Church, Delft), a splendid mixture of bronze and marble figures surrounding the effigy of the dead prince.

The minor arts of silversmithing and goldsmithing provided another medium for sculptors. Adam and Paulus van Vianen of Utrecht were known for their ornately decorated Mannerist plates and their ewers emblazoned with flowing arabesque forms; their work was succeeded in the middle of the century by the lush natural forms of the baroque silversmith Johannes Lutma. Throughout the late 16th and 17th centuries, fine ceramic tiles and vessels decorated with floral and other patterns were produced in great quantities at Delft and elsewhere in the Netherlands (see POTTERY AND PORCELAIN).

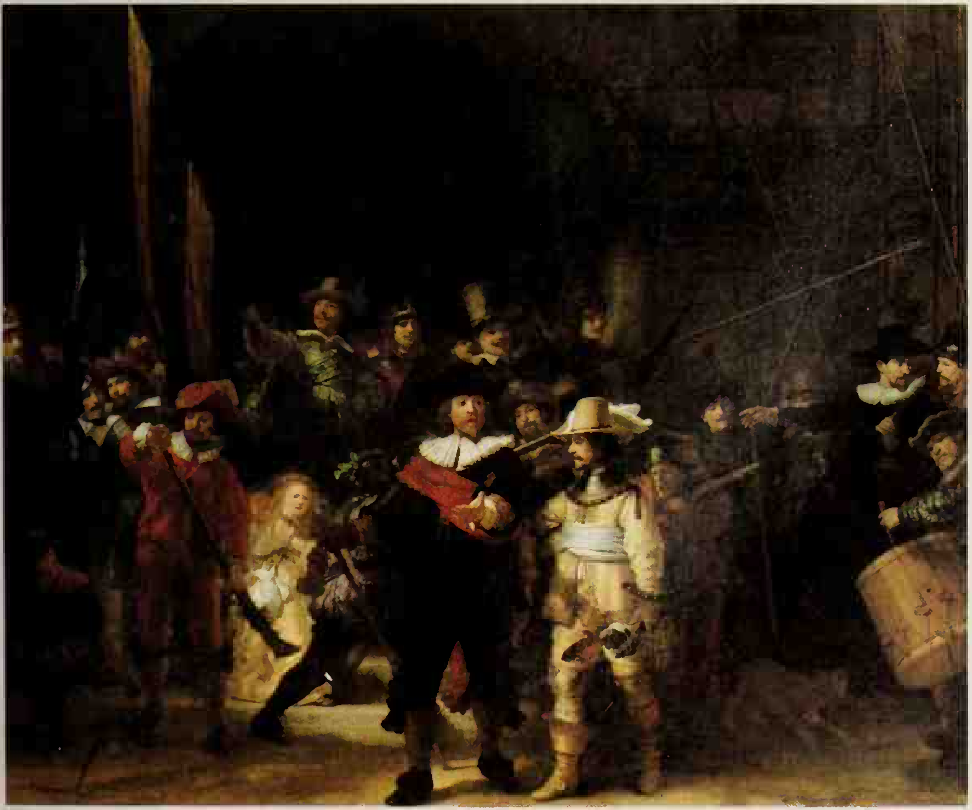
Later Centuries

In the 18th century, Dutch political power was eclipsed by that of Britain and France, and the Netherlands fell into economic stagnation. The influence of French art is strongly apparent throughout Dutch art of the period. Although the genre artist Cornelis Troost painted and drew amusing scenes from the contemporary stage, and Jacob de Wit executed superb rococo ceiling and wall decorations, their works are more French than Dutch in inspiration and orientation. Eighteenth-century Dutch architecture was likewise largely a derivative of contemporary French developments.

Not until the latter half of the 19th century did Dutch art recapture, especially in the artists of the Amsterdam and Hague schools, some of the power and individuality of the 17th century. Notable genre painters of this period include Jozef Israëls, whose works depict the grinding poverty of the peasant; and G. H. Breitner, who produced large powerful scenes of everyday life on the streets and canals of Amsterdam. The airy, atmospheric style of Johann Barthold JONGKIND, considered a forerunner of the



(Above) Jan Vermeer's The Art of Painting *(c. 1665) is one of the finest works by the great Dutch master of genre painting. This brilliantly colored depiction of the artist at work in his studio is rich in symbolic details of objects and dress. (Kunsthistorisches Museum, Vienna.)*

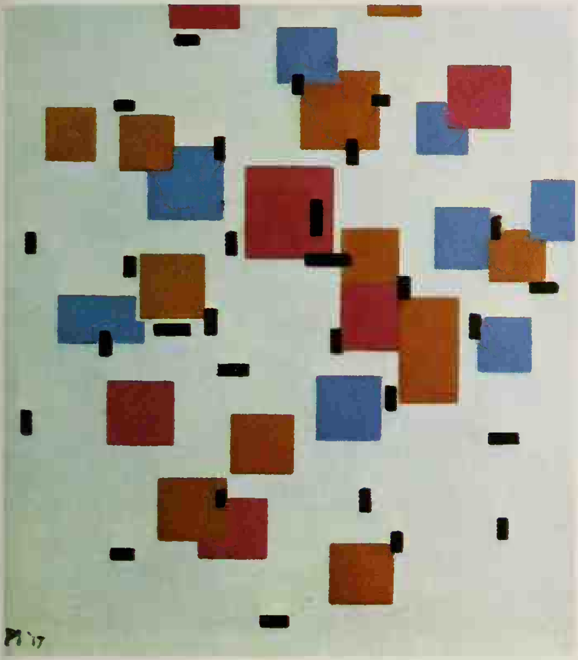


(Left) *Rembrandt painted this renowned group portrait titled* The Night Watch *(The Company of Captain Frans Banning Cocq and Lieutenant Willem van Ruytenburch) in 1642. The virtuosity of his baroque style is fully exemplified in this huge, complex composition. (Rijksmuseum, Amsterdam.)*

(Above) *This panoramic view of* The River Maas Near Dordrecht *(c. 1650) is one of several versions of the theme by Albert Cuyp, a major figure in 17th-century Dutch landscape painting. (Iveagh Bequest, Kenwood House, London.)*

(Left) *Vincent Van Gogh's* The Potato Eaters *(1885) is his most ambitious preimpressionist painting. The following year Van Gogh met the impressionists in Paris and began to use their bright colors and spacious landscapes as models for his expressive concerns. (Vincent Van Gogh Foundation, Amsterdam.)*

impressionists, was notably linked to the French BARBIZON SCHOOL. By far the greatest Dutch artist of the late 19th century was Vincent VAN GOGH. In his response to IMPRESSIONISM and POSTIMPRESSIONISM, his style was more French than Dutch; however, his early pictures of peasants, such as the naive yet powerfully expressive *Potato Eaters* (1885; Rijksmuseum Vincent van Gogh, Amsterdam), show his northern heritage.



Composition in Color B *(1917) by Piet Mondrian is an early example of de Stijl and neo-plasticism, two movements founded by Mondrian and Theo Van Doesburg. Mondrian creates a sense of depth and movement in an entirely abstract and nonrepresentational work. (Rijksmuseum Kröller-Müller, Otterlo.)*

One of the most significant 20th-century art movements, largely Dutch in origin, was DE STIJL ("the Style"), at its height in the second and third decades of the century. The major Dutch painter of this time and a cofounder, with Theo van DOESBURG, of the movement, was Piet MONDRIAN. His classically simple abstractions are among the greatest achievements of modern art. Such de Stijl architects as Gerrit RIETVELD won international acclaim for their modern building designs based on sleek, unadorned spaces and the smooth integration of simple forms.

After World War II the avant-garde painters of the CoBrA movement, in particular the Dutch painter Karel APPEL, strove to express the pain and fury of the war in contorted forms, harsh colors, and vigorous impasto technique. In the graphic arts, the engravings of Maurits Corneille ESCHER are noted for deft juxtapositions of metamorphic forms. Other prominent Dutch artists of the 1960s, '70s, and '80s include Jan Dibbets, Peter Struycken, Ger Van Elk, and Carel Visser.

Dutch East India Company see EAST INDIA COMPANY, DUTCH

Dutch East Indies see INDONESIA

Dutch elm disease see ELM

Dutch and Flemish literature Dutch literature is all literature written in the Dutch language, which is spoken in the Netherlands and the Flemish part of Belgium. From about AD 1200 writers began to use their own dialects, collectively referred to as Middle Dutch or *Diets,* the language of the people, as distinguished from Latin, the language of the church and of previous works written in the region. Most medieval Dutch literature originated in the provinces of Limburg, Brabant, and Flanders and was written in verse. Much of it was anonymous, although a Limburg nobleman, Heinric van Veldeke, wrote the earliest known work of Dutch literature, *Het Leven van Sin Servaes* (The Life of St. Servatius, *c.*1165). The much-imitated animal epic *Vanden vos Reinaerde* (Reynard the Fox, *c.*1200; Eng. trans., 1967) is a masterful satirical poem on abuses in society. The 14th-century Dutch plays known as *abele spelen* ("noble plays") are the oldest secular dramas in Europe. *Elckerlyc* (Everyman, *c.*1470) is the oldest known European morality play.

The 16th century produced a variety of literature, ranging from the polemical songs and tracts of the iconoclast reformationist *geuzen* (beggars) to the new poems and dramas inspired by competitions held in the popular *Rederijkers* (Chambers of Rhetoric) that emerged during this period. (The renowned 16th-century Dutch scholar ERASMUS, whose books were acclaimed throughout Europe, wrote in Latin.)

The Golden Age. After the Dutch Revolt against Spanish rule and the establishment of the Dutch republic early in the 17th century, the Netherlands experienced a golden age of art and literature. New genres and literary forms emerged. The Netherlands produced its first classical drama as well as its first classical comedy. Among the major writers were Pieter C. Hooft, poet, dramatist, essayist, historian, and translator; Joost van den VONDEL, considered the most important Dutch dramatist of all time; Gerbrand A. BREDERO, the first notable writer of Dutch comedy and farce; the statesman and poet Constantijn HUYGENS; and Jacob Cats, the immensely popular folk poet.

The 18th century, however, witnessed a sharp decline in the quality of Dutch literature. Influenced by the French classicists with their emphasis on rules, Dutch writers became uninspired and mechanical. An exception was the work of the team of Elizabeth Wolff and Aagje Deken (1741–1804), whose epistolary novel *Sara Burgerhart* (1782) provides a candid picture of the convictions of the staid middle class.

The 19th Century. In 1837 the poet E. J. Potgieter founded the literary journal *De Gids* (The Guide) whose proclaimed purpose was to foster a return to a literature that was truly representative of Dutch life. The influence of *De Gids* might be discerned in *Camera Obscura* (1839), a collection of satirical stories by Nicolaas Beets, and in the controversial autobiographical novel *Max Havelaar* (1860), by Eduard Douwes Dekker (1820–87), writing under the pseudonym Multatuli. Among the Flemish writers towers the simple figure of the poet-priest Guido Gezelle, whose voluminous nature poetry is written in his regional Flemish dialect.

Later 19th-century novelists tended toward naturalism. Frederik van Eeden (1860–1932), Marcellus Emants (1848–1923), and the most celebrated, Louis Couperus (1863–1923), all wrote novels in which character is formed or transformed by heredity, society, or—in Couperus's work—by "fate." His famous novel, *Van oude mensen, de dingen die voorbij gaan* (Of Old People, the Things That Pass, 1906; Eng. trans., 1963), depicts the disintegration of two old people through the revelation of a secret crime committed 60 years earlier.

The 20th Century. The early 20th century produced a new surge of writing from a group of Flemish authors, including the poet Karel van de Woestijne and the novelist Stijn Streuvels. Herman Heijermans was the great dramatist of this period; his *The Good Hope* (1901; Eng. trans., 1928) brought him a worldwide reputation. Scientist and physician Simon Vestdijk wrote more than 50 novels as well as volumes of short stories, poetry, essays, and criticism.

Contemporary novelists whose careers began before World War II include Marnix Gijsen and the Fleming Louis Paul Boon (1912–79). Hugo Claus (b. 1929) is an important Flemish novelist also active as a dramatist and film writer. W. F. Hermans (b. 1921), Gerard Reve (b. 1923), Harry Mulisch (b. 1927), and Jan Wolkers represent the major contemporary writers. All deal with issues that have become important since World War II: rebellion against society, alienation, the individual's responsibility for the cruelties of modern times.

Dutch Guiana see SURINAME

Dutch language see GERMANIC LANGUAGES

Dutch literature see DUTCH AND FLEMISH LITERATURE

Dutch Reformed Church see REFORMED CHURCH IN AMERICA

Dutch Revolt The Dutch Revolt was the struggle in the late 16th century by which the northern provinces of the Low Countries (the modern kingdom of the Netherlands) won independence from Spanish HABSBURG rule. The southern provinces (now incorporated chiefly in Belgium) also participated in the revolt, but Spain regained control in that area.

Religious and political factors fueled the revolt in the Netherlands. PHILIP II of Spain sought to counter spreading Calvinist influence by introducing the Spanish INQUISITION. Moreover, to centralize his control, he suspended the traditional political privileges of the provinces.

The revolt actually began in the southern provinces of Flanders and Brabant in 1566. In 1567 a Spanish army under the duque de ALBA was sent to quell the uprising, but the revolt spread under the leadership of WILLIAM I of Orange (William the Silent). By a treaty called the Pacification of Ghent (1576) all the provinces united to drive out the Spanish. Beginning in 1578 the Spanish governor Alessandro FARNESE won back the southern provinces by political concessions. The northern provinces of Holland, Zeeland, Utrecht, Gelderland, Overijssel, Friesland, and Groningen formed (1579) the Union of Utrecht and declared themselves a republic in 1581.

A Spanish priest (lower right) *offers a benediction at the mass execution of Dutch Protestants captured during the 16th-century revolt against Spanish rule. The Dutch Revolt was successful in the northern Netherlands, which achieved independence as the United Provinces.*

The Dutch were aided by the war between Spain and England, which forced the Spanish to fight on two fronts and made England a valuable Dutch ally. The SPANISH ARMADA of 1588 failed to destroy the alliance, and eventually Dutch forces under MAURICE OF NASSAU drove Spain's army out of the northern provinces. A 12-year truce in 1609 affirmed the virtual independence of the United Provinces, as the Dutch republic was known. Fighting was resumed during the THIRTY YEARS' WAR (1620–48), but the Dutch republic was accorded international de jure recognition by the Peace of Westphalia (1648).

Dutch Wars see ANGLO-DUTCH WARS

Dutch West India Company The Dutch West India Company was the creator of the 17th-century Dutch trading empire along the Atlantic coasts of Africa and the Americas. It received its charter in 1621, when the war to preserve Dutch independence from Spain was resumed after a 12-year truce. The company's most famous success came in 1628, off the coast of Cuba, when Piet Hein captured the Spanish silver fleet with its enormous and valuable booty.

Privateering, however, gave way to building colonies in Brazil, Dutch Guiana (now Suriname), the Antilles, and NEW NETHERLAND, which became a province of the company in 1623. The company also established fortresses on the west coast of Africa from which black slaves were shipped across the Atlantic. In 1654, however, Brazil was lost to Portugal, and in 1664 England took New Netherland. The company remained in deep financial difficulties until its demise (*c.*1794); its principal activity remained the slave trade.

The company's charter was not renewed in 1791, and its possessions and debts were taken over by the Dutch government.

Dutch West Indies see NETHERLANDS ANTILLES

Dutchman's-pipe is a woody climbing vine native to the eastern United States. Its flower resembles a meerschaum pipe.

Dutchman's-pipe Dutchman's-pipe, *Aristolochia durior,* is a hardy woody vine of the birthwort family, Aristolochiaceae. Also called pipe vine, its name comes from the brownish purple, tubular, U-shaped flowers, which resemble a meerschaum pipe. The vine grows rapidly, reaching 9 m (30 ft) in length. It makes an excellent screening plant because its large, rounded leaves, often 30 cm (1 ft) long, tend to remain flat against the growing surface. Dutchman's-pipe is found in woods and on stream banks from Pennsylvania to Georgia and Kansas and is also widely cultivated in gardens.

Dutton, Clarence Edward The American geologist Clarence Edward Dutton, b. Wallingford, Conn., May 25, 1841, d. Jan. 4, 1912, is known for his studies of western American landforms and for developing the concept of ISOSTASY. A graduate of Yale College in 1860, Dutton served in the U.S. Army during the Civil War. In 1875 the geologist and explorer John Wesley POWELL arranged for him to be assigned to the U.S. Geographical and Geological Survey of the Rocky Mountain region. Dutton transferred to the newly formed UNITED STATES GEOLOGICAL SURVEY in 1879 and remained there until 1890, when he returned to regular duty in the army.

The American geologist Clarence Dutton developed the theory of isostasy, a basic principle of structural geology, to explain how equilibrium is maintained by movements within the Earth's crust.

duty see TARIFF

Duvalier, François [due-vahl-ee-ay'] François Duvalier, called Papa Doc, b. Apr. 14, 1907, d. Apr. 21, 1971, was president of Haiti from 1957 until his death. In the 1940s Duvalier, a specialist in rural medicine, directed Haitian efforts toward eradicating yaws and malaria, both of which had reached epidemic proportions. He also joined Le Groupe des Griots, a writers' group that legitimized voodoo—a Haitian religion of African origin—and gave vent to cultural nationalism. Duvalier was an active supporter of President Dumarsais Estimé, under whom he served as director of public health (1946–48) and secretary of labor (1949–50). He opposed the regime of Paul E. Magloire, who came to power in 1950, and from 1954 to 1956 he worked underground, directing the antigovernment forces.

François "Papa Doc" Duvalier, a former physician, was elected president of Haiti in 1957 and, with the aid of the Tontons Macoutes, his private militia, instituted one of the world's most repressive regimes. In 1964, François Duvalier had himself invested as "president-for-life."

When Magloire resigned, Duvalier announced his candidacy for the presidency and was elected (1957) by the greatest majority in Haiti's history. By 1964, when Duvalier had the constitution revised to make him president for life, the authoritarian nature of his regime had become clear. Dissent was stifled by fear instilled through manipulation of voodoo imagery and by the Tontons Macoutes—a palace army responsible only to the president. His young son, Jean Claude, succeeded Duvalier.

Duvalier, Jean Claude Jean Claude Duvalier, b. July 3, 1951, succeeded his father, François "Papa Doc" Duvalier, as president for life of Haiti in April 1971. Duvalier initially promised economic reforms and a liberalization of the previous harsh regime and was able to attract some new foreign investment. In fact, however, there was little change. Popular protests against official corruption and extravagance erupted in November 1985; in January 1986 the United States reduced its aid to Haiti because of human-rights abuses. On Feb. 7, 1986, Duvalier turned the government over to an interim ruling council and, with his wife, boarded a U.S. Air Force jet for France and exile.

Duveen, Joseph, Baron Duveen of Millbank [doo-veen'] Joseph Duveen, 1st Baron Duveen of Millbank, b. Oct. 14, 1869, d. May 25, 1939, was an entrepreneur and patron of the arts in England and the United States. Duveen was the world's foremost art dealer for more than a quarter of a century. He determined much of the content of the major U.S. art collections from about 1900 to the time of his death, as well as presenting artworks to British museums and patronizing British artists.

Duveneck, Frank [doo'-vuh-nek] The American painter Frank Duveneck, b. Covington, Ky., Oct. 9, 1848, d. Jan. 3, 1919, was an important influence on other American artists of his generation. Such works as *Whistling Boy* (1872; Cincinnati Art Museum, Ohio) show how well he had absorbed the virtuoso brushwork and the skill in capturing fleeting expressions of the Dutch portraitist Frans Hals. In the 1870s he established a reputation as a leading painter, and then for many years taught and painted in Germany, Italy, and France. Although he is best remembered for such portraits as that of his wife, *Elizabeth Booth Duveneck* (1888; Cincinnati Art Museum), he was also a figure and landscape painter as well as a fine etcher.

Dvina River, Northern [dvee-nah'] The Northern Dvina River, located in the north-European USSR, is 750 km (465 mi) long. Formed by the joining of the Sukhona and Yug rivers, it flows northwest to Dvina Bay, an arm of the White Sea, below Arkhangelsk (Archangel). Navigable over its entire course during summer, the Northern Dvina was made more useful to commercial shipping by linkage with the Volga-Baltic Waterway, completed in 1964.

Dvina River, Western The Western Dvina River is located in the western USSR. About 1,015 km (630 mi) long, it rises in the Valdai Hills and flows generally westward through Belorussia and Latvia, emptying into the Gulf of Riga. The Western Dvina's drainage area is about 85,500 km^2 (33,000 mi^2).

The Bohemian composer Antonín Dvořák became prominent at a time when many Bohemians were advocating independence from the Austrian Empire. Dvořák reflected this rising spirit of nationalism in his music.

Dvořák, Antonín [dvor'-zhahk] Antonín Leopold Dvořák, b. Sept. 8, 1841, d. May 1, 1904, was the greatest Bohemian composer and one of the leading masters of symphonic and chamber music of the late 19th century. At age 16 he went to Prague to study organ and composition, supporting himself as a violist and piano teacher. His first successful composition was *Hymnus* (1873), a patriotic choral work. His fame grew steadily—in part owing to encouragement from Johannes Brahms and the powerful Viennese critic Eduard Hanslick—and after the publication of the first set of his *Slavonic Dances* (1878), Dvořák enjoyed wide popularity.

In 1892, Dvořák became director of New York's National Conservatory. During his three-year tenure he composed his most popular work, Symphony no. 9, *From the New World* (1893), as well as his popular cello concerto (1895). Dvořák became director of the Prague Conservatory in 1901. In the same year, the most successful of his ten operas, *Rusalka*, premiered at the Prague National Theater.

Although Dvořák is best known for his orchestral music—which includes nine symphonies, several overtures and symphonic poems, the *Slavonic Dances*, the *Scherzo Capriccioso*, and many others—much of his finest music is found in his string quartets and other chamber works, particularly the Piano Quintet in A. Most of his songs have the flavor of Czech folk melody, which is also present—if more subtly—in his other music. Among his choral works are the *Stabat Mater* (1877), *Requiem* (1890), and *Te Deum* (1892).

dwarf gecko Dwarf gecko refers to any lizard of the genus *Sphaerodactylus* in the gecko family, Gekkonidae. Dwarf geckos, native mainly to the West Indies, are generally less than 80 mm (3 in) long. *S. elegans*, at less than 30 mm (1.2 in) in total length, is one of the smallest reptiles in the world. Dwarf geckos tend to be less nocturnal than most other geckos, and they lack a voice. They lay only one egg at a time.

dwarfism see ENDOCRINE SYSTEM, DISEASES OF THE

Dwight, Timothy Timothy Dwight, b. Norwich, Conn., May 14, 1752, d. Jan. 11, 1817, was an American Congregationalist minister and educator. A grandson of Jonathan Edwards, Dwight was a pastor before becoming president of Yale College in 1795. He brought energetic leadership to Yale, establishing professional schools for medicine and theology and attempting to modernize the curriculum. Dwight was also a respected preacher.

Dyak see DAYAK

Dyck, Sir Anthony van see VAN DYCK, SIR ANTHONY

dye A dye is a colored substance used to impart more or less permanent color to other substances. Dyes color nearly all manufactured products, but their most important use is in coloring textile fibers and fabrics. Virtually all industrial dyes used today are synthetic. The only significant dye produced from natural substances is logwood, which is used primarily as a black dye for nylon.

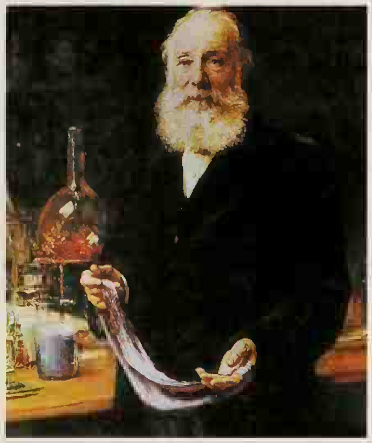
Mordants

A dye must have an affinity for the substance it colors; that is, it must enter and adhere to the interior of the fiber. Natural dyestuffs usually have no affinity for cellulosic fibers such as cotton or flax and can be used only with the aid of a mordant (a substance that attracts and fixes the dye in the fiber). The effect of the mordant is to make the dye washfast and lightfast.

History of Dyes

Until the mid-19th century, all dyes were derived from natural substances from plants and animals. TYRIAN PURPLE, used by the Phoenicians in the 15th century BC, was produced from certain varieties of crushed sea snails. Another snail variety, the banded dye-murex, was discovered in the 1980s to be the source of hyacinthine purple, a blue purple dye known in biblical Hebrew as *tekhelet* and employed up to 3,600 years ago for dyeing ritual prayer shawls. The use of INDIGO as long ago as 3000 BC has been documented.

Brilliant scarlet and saffron cloth overhangs this bazaar in Marrakesh, Morocco. Until the 19th century, all fabrics were dyed with colorings derived from vegetable and animal sources.



Sir William Henry Perkin discovered the first synthetic dye, aniline purple, or mauve, in 1856. He initiated the synthetic dye industry in England when he opened a factory to produce the substance.

The textile-dyeing industry in Europe originated in the 16th century, when the Portuguese, Dutch, and English introduced indigo. Natural dyes such as cochineal, TURMERIC, WOAD, madder, and HENNA remained the primary source of dye colors until the discovery of the first synthetic dye in 1856 by Sir William Henry Perkin.

Perkin, an English chemist, was working with the coal-tar derivative aniline, when he accidentally discovered that a by-product of aniline oxidation had dyeing capabilities. He established a factory to manufacture his new purple dye, mauve; other experimenters began to produce new colors from aniline and other COAL TAR derivatives. Alizarin was the first natural dye to be produced synthetically (1868), and by 1880 indigo had been synthesized.

Types of Dyes

Almost all dyes fall into one of the following categories:

Vat dyes are extremely fast dyes applied particularly to cotton. The water-insoluble dye is reduced in a vat to a water-soluble compound. After the fabric is dyed, it is exposed to air or to a chemical oxidizing agent, and the dye reverts to its insoluble form.

Sulfur dyes, used to produce deep shades on cotton, are inexpensive dyes made by the reaction of various organic chemicals with sulfur or sodium sulfide.

Direct dyes are azoic dyes to which common salt or sodium sulfate has been added; they can be applied directly to cotton or other cellulosic fibers.

Acid dyes are used for wool, silk, and some synthetics. They are water-soluble and can be applied directly to the fiber.

Disperse dyes, soluble in acetate but not water, are used to dye polyester, polyamides, and other synthetic fibers.

Basic dyes include most of the first synthetic dyes, which are used for fabrics such as wool, silk, nylon, and acrylics. They are particularly brilliant, and most fluorescent dyes are basics.

Metal-complex dyes, used primarily on wool, are combinations of a dyestuff and a metal, usually chrome. They are highly lightfast and washfast.

Reactive dyes, the newest dye class, function in an entirely different manner from other dyes. Reactive dyes become a part of the substrate molecule (see CHEMICAL BOND), and they are therefore exceptionally fast. The most important in this group are the azo dyes, a group of organic compounds (see AZO COMPOUND) whose dyeing properties are based on their linkage by a nitrogen, or azo bond.

Dyeing Methods

Fibers are dyed by a process called yarn dyeing: skeins of yarn are moved through hot dye liquor or are wound onto perforated tubes through which the dye liquor is pumped. Piece dyeing is the dyeing of individual lengths of fabric. In continuous processing, cloth is passed through a concentrated dye solution, then through heated squeeze rolls that fix the dye and dry the cloth. Continuous dyeing machines can dye thousands of yards of cloth in one processing. In batch dyeing, a loop of cloth is pulled through a hot dyebath.

Dyeing machines and solutions are always heated to increase the affinity between dye and substrate. Many modern machines operate under pressure so that temperatures above the boiling point of water can be achieved.

Dyer, Mary [dy'-ur] Mary Dyer, b. *c.*1610, d. June 1, 1660, was a Quaker martyr in 17th-century New England. Raised in England, she and her husband, William, emigrated to Boston in 1635. Dyer allied herself with Anne HUTCHINSON in the belief that trust in God is more important than obedience to laws. When Hutchinson was expelled (1638) from the church by Puritan authorities, Dyer and her family moved to Rhode Island. She returned to England in 1650 and during her stay there joined the Society of Friends (Quakers). On her way back to Rhode Island, she passed through Boston, where she was arrested and imprisoned. After her release, Dyer persisted in returning to Boston to visit imprisoned Quakers. She was finally sentenced to death and hanged.

Dyer-Bennett, Richard [dy'-ur-ben-et] Richard Dyer-Bennett, b. Oct. 6, 1913, is a singer known for his performances and recordings of folk songs from many nations. Born in England, he attended the University of California, becoming a U.S. citizen on his 21st birthday. By 1941 he was singing to his own lute accompaniments in New York night clubs. Dyer-Bennett's high tenor voice, crystalline diction, and self-effacing manner won him a loyal following.

Dyfed [div'-ed] Dyfed is a county in southwestern Wales, situated on Cardigan Bay and the Bristol Channel. The population of Dyfed is 348,400 (1988 est.), and the county covers an area of 5,765 km^2 (2,226 mi^2). The high, hilly plateau covering much of Dyfed has an average elevation of about 500 m (1,650 ft) and ends in steep cliffs at the coast. In the northwest, the Cambrian Mountains reach 753 m (2,469 ft) at Plynlimon Fawr. Agriculture, primarily dairying, takes place in the fertile river valleys, and sheep and beef cattle are raised at higher elevations. Anthracite is mined in the southeast; most industry is also concentrated there, especially at Llanelly and Milford Haven, where a large oil refinery is located. ABERYSTWYTH and other coastal towns are tourism centers. Many Neolithic barrows and stone circles are found in southwestern Dyfed. In 1974, when the local government of Wales was reorganized, Dyfed was created from the former counties of Cardiganshire, Carmarthenshire, and Pembrokeshire.

Dylan, Bob [dil'-in] Bob Dylan, born Robert Allen Zimmerman in Duluth, Minn., May 24, 1941, is a singer, songwriter, and guitarist. Dylan was perhaps the most influential voice of the protest era of the early 1960s and became one of the leading musicians in the field of folk rock. Influenced by Woody Guthrie and the blues genre, he began his career as a folksinger in 1960. His song "Blowin' in the Wind" became the anthem of the civil rights movement, and the protest songs he wrote from 1961 to 1964 seemed to express the hopes and angers of his generation. In 1965, Dylan turned to rock music.

Dylan's 5-record set, *Biograph* (1985)—which contains over 50 of his songs written from 1961 to 1981—chronicles the changes in Dylan's musical attitudes: fiery and impassioned in the early years; more personal, withdrawn, and apolitical as the years wear on.

dynamics Dynamics is a part of the field of mechanics, which is a branch of physical science. Dynamics deals with the motion of objects and material under the influence of applied forces. It is one of the oldest and most basic branches of physics.

The fundamentals of classical dynamics were stated by Isaac Newton in his book *Principia Mathematica Philosophiae Naturalis* (1686). Newton's LAWS OF MOTION and GRAVITATION were sufficient to describe almost all motion of practical interest for over two centuries until 1905, when Albert Einstein proposed his theory of RELATIVITY. Einstein's mechanics extended Newtonian dynamics to include motion at speeds approaching that of light. Later, Max Planck, Werner Heisenberg, and others developed QUANTUM MECHANICS to describe motion on a subatomic scale.

dynamite see EXPLOSIVES

dynamo see GENERATOR

dyne [dyn] In the cgs (centimeter-gram-second) system of units, a dyne is the unit of force or weight, defined as the amount of force required to impart a 1 cm/sec^2

acceleration to a 1-gram mass. A dyne is equal to 10^{-5} (one hundred-thousandth) newton. A 1-kilogram mass weighs 980,665 dynes.

See also: ERG; UNITS, PHYSICAL.

dysentery Dysentery is an inflammation of the intestine that causes painful DIARRHEA and stools containing blood and mucus. One type, bacillary dysentery, is caused by *Shigella* bacteria; and another, amoebic dysentery, by a protozoan, *Entamoeba histolytica.* Bacillary dysentery occurs mainly in children; the symptoms are fever, abdominal cramps, and diarrhea that lasts about a week. It severely affects infants, the elderly, and the malnourished, especially in the tropics, and may be fatal. Generally treatment consists of drinking large quantities of fluids, but antibiotics are given in severe cases. The disease is transmitted by the stools of infected persons and is prevented by good hygiene. Amoebic dysentery is an ulcerative condition of the intestine, from which the amoebas may invade the liver or, rarely, the skin and lungs, and cause abscesses. Treatment is emetine injections or metronidazole taken orally.

dyslexia [dis-lek'-see-uh] Dyslexia is a developmental disorder marked by difficulty in learning to read despite adequate intelligence, conventional instruction, and sociocultural opportunity. It appears to occur in 5 to 10 percent of the general population, and affects boys 3 to 6 times as frequently as girls. A number of subtypes of dyslexia probably exist with different origins and associated symptoms. The problem does not lie in perceiving words correctly; dyslexia is instead usually related to some kind of language impairment and is often associated with verbal memory problems. In particular, dyslexics have trouble analyzing spoken or written words into smaller units of sound, or phonemes.

The underlying causes of dyslexia are presumed to involve some kind of neurological dysfunction. Evidence exists for both genetic and environmental causes of such dysfunction. Dyslexia can run in families, and it has also been related to problems arising during birth.

There are three main kinds of approaches to dealing with dyslexia. The developmental approach simply intensifies conventional methods of instruction. The corrective approach emphasizes the dyslexic individual's assets and interests. The remedial approach focuses on deficiencies. Reading skills can be improved to some degree, but problems tend to persist into adulthood.

dysmenorrhea see MENSTRUATION

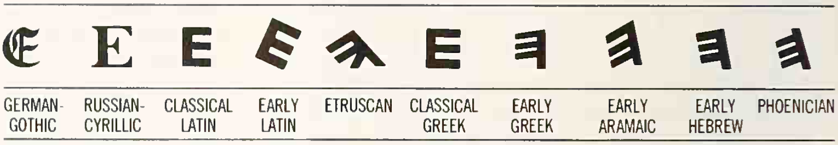
dysplasia [dis-play'-zhuh] Dysplasia is a general term for various abnormal tissue developments, exclusive of malignant disorders. The term usually refers to one of the following: abnormal cell structures; the proliferation of a tissue where it does not normally occur (for example, bone at a site where fibrous tissue normally occurs); excessive growth of an otherwise normal tissue; or the complete absence of tissue growth where growth normally occurs. At least 25 different types of dysplasia are described in medical practice. These include: cervical dysplasia, often called zero-grade cancer of the uterine cervix, which consists of abnormally structured cells that may eventually become cancerous and invade the uterus; hereditary renal-retinal dysplasia, a disorder of kidney and retinal cells that leads to atrophy of the retina and progressive UREMIA; chondroectodermal dysplasia, or Ellis–van Creveld syndrome, typified by insufficient growth of the long bones in childhood and resulting in a form of dwarfism; diaphysial dysplasia, or Engelmann's disease, characterized by excessive growth of the long bones; and spondyloepiphysial dysplasia, which involves insufficient growth of the vertebrae and results in a form of dwarfism.

dysprosium [dis-proh'-zee-uhm] The element dysprosium is a silver-gray, rare earth metal in Group IIIB of the periodic table (see LANTHANIDE SERIES). Its symbol is Dy, its atomic number is 66, and its atomic weight is 162.50. The element was identified in 1886 but was not isolated until 1950. Its name is derived from the Greek word *dysprositos,* meaning "difficulty of access." Seven isotopes occur naturally. Dysprosium has a valence of +3. Its oxide, Dy_2O_3, is used in control devices for nuclear reactors because the metal has a high neutron-absorbing capability, and in cryogenic cooling devices because it is one of the most paramagnetic substances known (see MAGNETISM).

Dzerzhinsky, Feliks Edmundovich [dzir-zheen'-skee, fyel'-yiks ed-moon'-duh-vich] Feliks Edmundovich Dzerzhinsky, b. Sept. 11 (N.S.), 1877, d. July 20, 1926, was the organizer of the Cheka, the first Soviet secret police organization. A Pole, he joined the Social Democratic party in 1895 and during the following 22 years was frequently imprisoned for revolutionary activities. After the first of the RUSSIAN REVOLUTIONS OF 1917, Dzerzhinsky became head of the Military Revolutionary Committee of the Petrograd Soviet. This organization played a leading role in the Bolshevik Revolution of November (N.S.) 1917, after which it evolved into the Cheka (the All-Russian Extraordinary Commission for Combatting Counterrevolution and Sabotage). A harsh fanatic, Dzerzhinsky directed the Cheka in its ruthless use of terror against all dissenters.

Dzubas, Friedel Friedel Dzubas, b. Berlin, Apr. 20, 1915, is a leading exponent of American COLOR-FIELD PAINTING. His first one-man show in New York was held in 1952, but it was not until the 1960s that he developed his mature style. Like Helen FRANKENTHALER and Jules Olitski, Dzubas constructs an allover field with the juxtaposition of high-keyed or pastel colors on the surface of a large canvas. Many color-field painters employ either small or overlapping units of color; Dzubas, however, tends to build his field effects from large blocks of color close set on empty backgrounds. He has also experimented with combinations of high- and low-keyed color.

Ee



E *E/e* is the fifth letter of the English alphabet. Both the form of the letter and its position in the alphabet were derived from the Latin alphabet, which, in turn, took it from the Greek by way of the Etruscan. The Greeks call the letter *epsilon*. Both the form and the position of the letter were taken by them from a Semitic writing system.

In modern English pronunciation, *E/e* has two basic sounds: a short *e*, as in *bed*, and a long *e*, as in *be*. The long *e* sound is frequently written *ee*, as in *seem*, or *ea*, as in *peak*. The final *E/e* is normally silent in modern English; it indicates that the preceding vowel is to be pronounced long (*fat/fate*). When the final *E/e* is meant to be pronounced, mostly in words borrowed from Romance languages, it is usually marked with an accent and is pronounced as a long *a* (*fiancé*). *E/e* is the most frequently used letter of the English alphabet, in large measure because of a tendency to reduce all unstressed vowels to the sound of short *e*.

e In mathematics the letter *e* is used to represent the irrational number 2.7182818284590...; this number is the base both of the system of natural logarithms and of the exponential function $y = e^x$. Natural logarithms are more useful than common logarithms (which use 10 as a base) in studying motion and many other natural phenomena, because the value *e* is related to rates of change and growth observed in the natural world. The numerical value of *e* can be calculated to any desired degree of accuracy through the use of a simple mathematical series.

e pluribus unum The Latin motto *e pluribus unum* ("from many, one") appears on the Great Seal of the United States and on all U.S. coins. It was chosen by a committee appointed on July 4, 1776, by the Continental Congress "to prepare a device for a Seal of the United States of America." Committee member Benjamin Franklin proposed the motto "Rebellion to Tyrants is Obedience to God," but the phrase *e pluribus unum* was chosen by the committee and officially adopted on June 20, 1782. The phrase is from the poem "Moretum," attributed to Vergil.

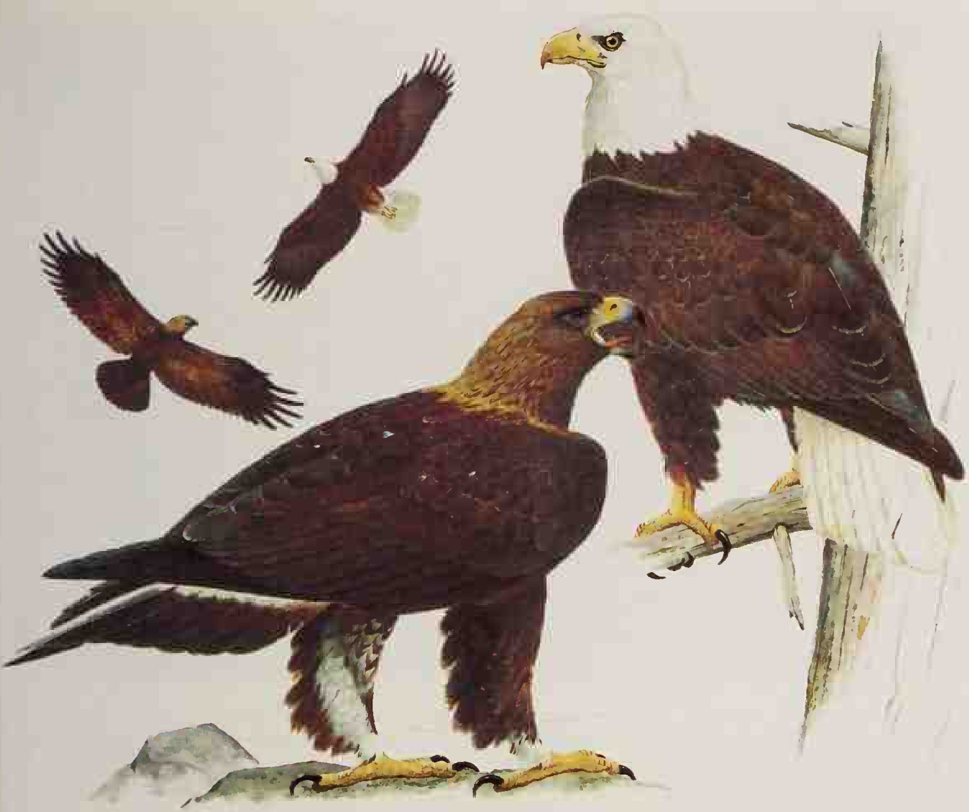
Ea [ay'-ah] In Babylonian mythology Ea, or Enki, was the water god, a universal deity who surrounded the world. He was part of the divine triad that ruled the cosmos, the other two divinities being Anu, the sky god, and Enlil (later identified with Marduk), the Earth god. Ea was the god of wisdom, knowledge, and incantation and the patron of craftsmen.

eagle Eagles are large predatory birds that have been symbols of power, courage, and immortality since ancient times. The more than 50 species all belong to the hawk family, Accipitridae, order Falconiformes. Eagles inhabit all major land regions except Antarctica and New Zealand. Although once abundant, some eagles are becoming rare and face extinction. One rare species is the bald eagle, *Haliaeetus leucocephalus,* the national emblem of the United States. Although protected by law, some large eagles are killed by farmers and gamekeepers or captured for use in falconry. In addition, the bald eagle, like other birds, has been affected by the widespread use of pesticides that, ingested, can weaken eggs.

Appearance. Eagles are noted for their strength and keen vision. Most eagles range from 60 to 90 cm (2 to 3 ft) in length and have wingspans of about 180 cm (6 ft). One of the smallest, the Ayres' eagle, *Hieraetus dubius,* is only 40 cm (16 in) long; the largest, the harpy eagle, *Harpia harpyja,* reaches 100 cm (39 in) in length, with a wingspan up to 2.4 m (8 ft).

All eagles have large, heavy, hooked bills and strong, sharp claws called talons. They are usually brown, black, or gray, sometimes with markings on the head, neck, wings, or tail. The bald eagle is not really bald; it was named for its white head. The rest of its plumage is brown, except for its white tail. Some eagles have a ring of pointed feathers around the head; others, called booted eagles, have feathers on their legs all the way to their talons. One booted eagle native to the Northern Hemisphere, the golden eagle, *Aquila chrysaetos,* is brown with golden tints on the head and back of the neck.

Habits. Eagles prey on such small animals as fish, rodents, birds, snakes, monkeys, and rabbits. They have very sharp eyesight and hunt while soaring high in the air or watching from a high perch. They swoop down at great speed to make the kill with their powerful talons. With talons and beak they pull apart a prey that is too heavy to carry. Sometimes they steal the catch of other birds, such as ospreys.



The eagle, a majestic bird with a large wingspan, soars to high altitudes, diving to earth when it spots its prey. The golden eagle (left), *found in northern countries of the world, frequently occupies a nest, or aerie, that was built centuries ago. The American bald eagle* (right), *the national emblem of the United States, is named for its white head feathers, which contrast with darker body plumage.*

The eagle's nest, or aerie, is high in a tree or on a rocky ledge where it cannot be reached by other animals. This precaution is necessary because young eagles remain helpless for a long period. The nest, which is often used by the same pair of birds year after year, is made of sticks and lined with grass and leaves. The largest known nest ever measured was 6.1 m (20 ft) deep and 3 m (9.8 ft) across.

The female eagle generally lays one to three brownish, speckled eggs. Either both parents or just the female incubates the eggs, and the female usually feeds the young. The babies, which are covered with down, remain in the nest from 50 to 100 days, depending on the species. They do not develop adult coloration until they are more than 2 years old.

Eagleton, Thomas F. Thomas Francis Eagleton, b. St. Louis, Mo., Sept. 4, 1929, was the Democratic senator from Missouri from 1969 until 1987. He was nominated in 1972 to run for vice-president of the United States with presidential nominee Sen. George McGovern. After admitting that he had been hospitalized three times for nervous disorders and had received electroshock therapy, he was forced to withdraw.

Eakins, Thomas [ay'-kinz] Although he received little recognition in his lifetime, Thomas Cowperthwaite Eakins, b. Philadelphia, July 25, 1844, d. June 25, 1916, has come to be regarded in the 20th century as the greatest realist in the history of American art. He brought to his work a close personal involvement with his subjects and intense scientific interest in anatomy, light, and perspective.

Eakins painted outdoor scenes that included views of sportsmen on rivers and bays near the city, such as *Max Schmitt in a Single Scull* (1871; Metropolitan Museum, New York City). In 1875 he painted a far more ambitious picture, now accepted as his masterpiece, a large portrait of the eminent surgeon Dr. Samuel Gross, *The Gross Clinic* (1875; Jefferson Medical College, Philadelphia). Gross is shown scalpel in hand, lecturing to his students about the operation he is performing, the details of which, including an open incision, are clearly depicted. The painting's bold realism appropriately reflects the clinical objectivity of Dr. Gross's approach to medicine but offended Eakins's prudish audience.

Eakins taught at the Pennsylvania Academy of Fine Arts from 1876 to 1886, when he was forced to resign after a dispute caused by his insistence that students of both sexes be allowed to draw from nude models. In the 1880s, Eakins conducted photographic experiments at the University of Pennsylvania about human-body movement that anticipated the invention of the motion picture and coincided with the pioneering work of Eadweard Muybridge. After 1880 most of his works were portraits, often of the scientists, physicians, scholars, and students of Philadelphia

Max Schmitt in a Single Scull *(1871),* *by the American realist painter Thomas Eakins, shows careful use of light and perspective. (Metropolitan Museum, New York City.)*

who were his friends. He had little commercial success and was largely ignored by the art world despite the fact that he was an outstanding figure painter and the best portraitist in America since Gilbert STUART, whose work was much narrower in scope. In 1902 he was belatedly elected to the National Academy of Design, by which time his creative powers had begun to wane. After 1910 he was in ill health and ceased to paint. His influence on the so-called ASHCAN SCHOOL realists of the early 20th century was great, although full recognition of his many achievements as an artist and teacher came only in the 1930s.

Among Eakins's finest paintings is *William Rush Carving His Allegorical Figure of the Schuylkill* (1877; Philadelphia Museum of Art), a subject to which he returned late in his career. (William RUSH was a Philadelphia wood-carver of the Federal period whose use of a nude model aroused a controversy of the kind that Eakins was often involved in.) The psychological penetration of his portraits is evident in the mirthful spirit of his *Walt Whitman* (1888; Pennsylvania Academy of Fine Arts) and the introspective serenity of *Miss Van Buren* (*c.*1891; Phillips Collection, Washington, D.C.).

Eakins also worked as a sculptor and made notable contributions to the art of photography, but his paintings were his supreme achievement. Along with those of Winslow HOMER, they represent the culmination of the development of American art in the 19th century.

EAM-ELAS [ay-ahm' ay-lahs'] EAM and ELAS were acronyms for the Greek names of the National Liberation Front and the Greek Popular Liberation Forces, respectively; both were Communist-controlled resistance groups that fought against German occupation forces in Greece during World War II. EAM, formed in 1941, was a political organization; ELAS, formed the following year, was its military wing. EAM-ELAS controlled two-thirds of Greece when the Germans withdrew in October 1944. It attempted to take over the government in December but was thwarted by British forces. A second rebellion, supported by Greece's Communist neighbors, began in 1946 and was not finally quelled until 1949.

Eames, Charles [eemz] The versatile American architect and designer Charles Eames, b. St. Louis, Mo., June 17, 1907, d. Aug. 21, 1978, was best known for his utilitarian, mass-produced furniture. In 1941 he won first prize in a furniture-design competition at New York City's Museum of Modern Art, with designs employing plywood shells molded in multiple curves, an innovation that enhanced the furniture's sculptural qualities while greatly increasing its strength. Eames was assisted by the artist Ray Kaiser, whom he married in 1941. Together they developed low-cost techniques for wood lamination and molding that enabled them to mass-produce their furniture, beginning in 1946 after an unprecedented one-man design show at the Museum of Modern Art.

Charles and Ray Eames undertook a wide range of other design projects. Their films include *A Communications Primer* (1953), *Bread* (1953), and *Powers of Ten* (1969). The Eames's own house and studio near Los Angeles, designed in 1949, was an important postwar architectural landmark. Inexpensive, mass-produced materials—particularly prefabricated factory components—were used throughout. The resulting restraint and simplicity recall Japanese domestic architecture without the severity of the International Style, with which it has been compared.

Eanes, António dos Santos Ramalho [ay-ahn'-esh] António dos Santos Ramalho Eanes, b. Jan. 25, 1935, was president of Portugal from 1976 to 1986. An army officer, he fought in the colonial wars in Africa. After the revolution of Apr. 25, 1974, he headed the Portuguese Television network and became army chief of staff in December 1975. In June 1976, Eanes, a nonparty candidate, was elected president of the republic and head of the left-wing revolutionary council.

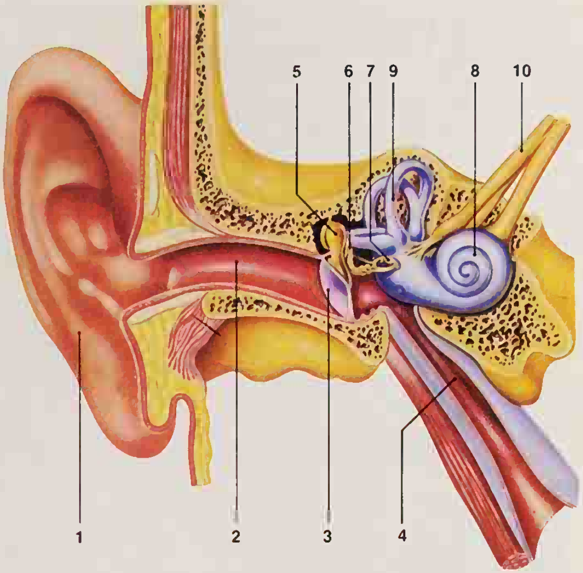
ear The ear is the organ of hearing and equilibrium (balance) in vertebrates. The ear converts sound waves (see SOUND AND ACOUSTICS) in the air to nerve impulses that are relayed to the brain, where they are interpreted as sound rather than as mere vibrations. The innermost portion of the ear maintains BIOLOGICAL EQUILIBRIUM through the so-called vestibular apparatus, which includes the semicircular canals. Any change in the position of the head or body causes the apparatus to transmit nerve impulses to the brain, evoking muscular reflexes that tend to restore the normal position. The ear first evolved as an organ of equilibrium, and the vestibular apparatus is basically alike in all vertebrates; hearing structures evolved later in the higher vertebrates.

Many invertebrates also have specialized sense organs, rather than ears, for hearing and equilibrium. Crickets and spiders, for example, have membranes much like sounding boards on the legs. Moths have a similar rudimentary ear on the thorax that apparently serves as a warning system for attacks by bats.

Structure of the Ear

The ear in humans and most other mammals consists of three parts: the outer, middle, and inner portions. The outer ear, or pinna, is the structure commonly called the ear. It is a skin-covered flap of elastic cartilage projecting from the side of the head and funneling sound into the middle ear. The middle ear is an air-filled chamber containing the eardrum, or tympanic membrane, and connected to the pharynx by the eustachian tube, thus equalizing the pressure on the two sides of the eardrum. The inner ear contains the sensory receptors for hearing; these receptors are in a fluid-filled chamber called the cochlea. The middle and outer ears serve only to receive and amplify sound waves and occur only in amphibians and mammals, whereas the inner ear is present in all vertebrates.

In fish, the inner ear is primarily an organ of equilibrium and lacks a cochlea; nor do fish have outer or middle ears. Amphibians possess a middle ear cavity; a thin membrane separating the middle ear from the outside becomes the eardrum. The pinna occurs only in mammals. In birds and reptiles, the eardrum may be in a depression (the auditory canal) below the surface of the head.



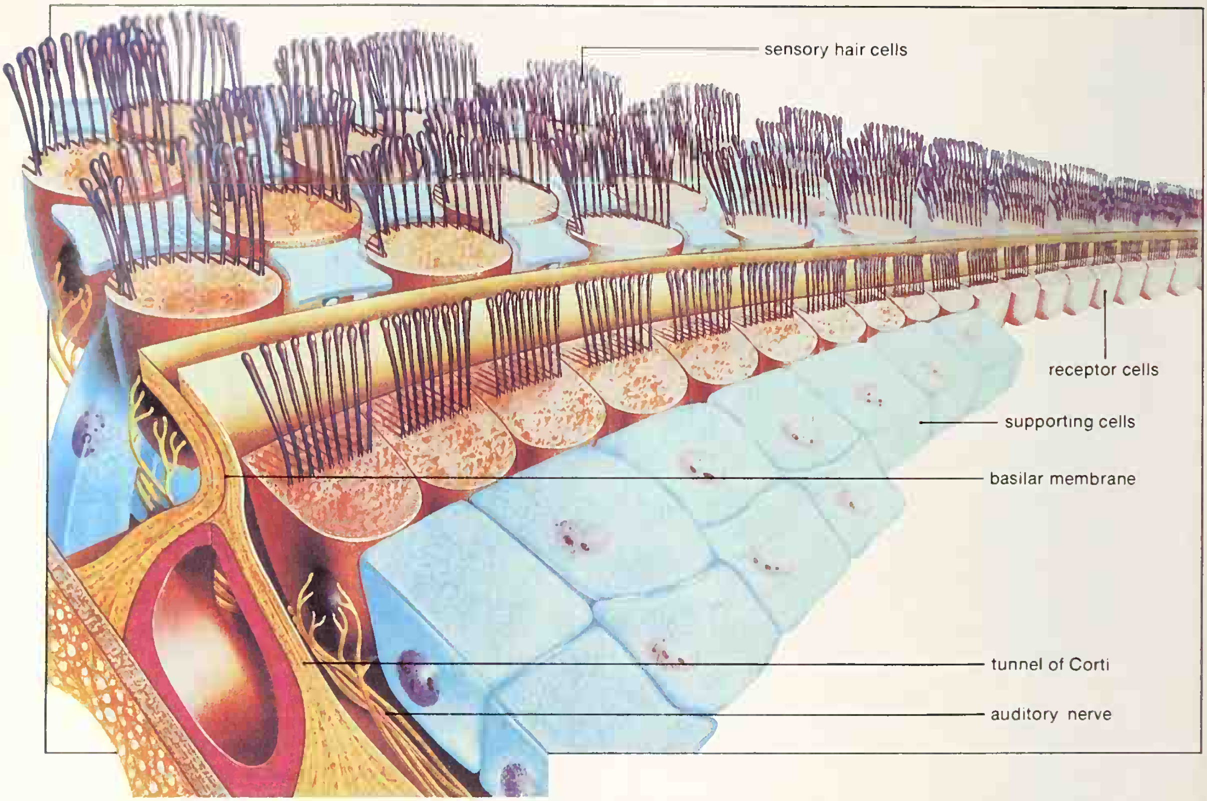
Structurally, the human ear is divided into an outer, middle, and inner ear. The pinna (1) of the outer ear receives sound waves, which travel through the auditory canal (2) to the middle ear. The eardrum (3), a thin membrane separating the outer from the middle ear, vibrates from the impact of the sound waves. The middle ear is filled with air that comes from the mouth through the eustachian tube (4). This chamber contains three tiny bones—the hammer (5), the anvil (6), and the stirrup (7)—that extend from the eardrum to the inner ear. The inner ear includes the cochlea (8), which contains the organ of Corti, and the vestibule (9), which maintains balance. The auditory nerve (10) sends messages from the inner ear to the brain.

Hearing

The characteristics of sound that can be detected by the human ear include volume, pitch, and tone. In general, sound volume depends on the amplitude, or intensity, of the sound wave; the greater the amplitude, the louder the sound. Pitch is related to the frequency of the sound wave, or the number of waves per unit time passing a point of reference; the greater the frequency, the higher the pitch. Variations in tone, or quality, such as are produced when an oboe and a violin play the same note, depend on the number and kind of overtones or harmonics (combinations of frequencies).

Humans can hear frequencies between about 30 and 20,000 waves, or cycles, per second (cps, or Hertz, abbreviated Hz). A whistle producing 30,000 Hz is audible to dogs. Some bats can produce and hear sounds of approximately 100,000 Hz, in the ultrasonic range, and use this ability in their highly evolved system of navigation known as ECHOLOCATION.

Experiments indicate that humans and other higher vertebrates hear in much the same way. Basically, the ear is adapted for transmitting vibrations from air to the fluid medium of the cochlea. Sounds travel down the auditory canal and cause the eardrum to vibrate. The vibrations are transmitted through the middle ear by a sequence of



The organ of Corti, located in the cochlea of the inner ear, receives sound vibrations and translates them into nerve impulses for the brain. The organ consists of more than 20,000 sensory hair cells anchored in receptor cells of the basilar membrane. Vibrations transmitted from the middle ear set cochlear fluid in motion, which disturbs the hair cells. These hair cells stimulate neurons connected to the auditory nerve of the brain.

three tiny bones, the auditory ossicles, called, because of their shapes, the hammer, anvil, and stirrup. The last of the bones, the stirrup, rests on a membrane-covered opening (the oval window) in the bony wall of the snail-shaped cochlea and carries the vibrations to fluids inside the cochlea. The vibrations create waves on the basilar membrane, which runs along the length of the cochlea.

The true sound receptors are thousands of specialized hair cells, in the organ of Corti, spread across the basilar membrane. The deformation of the hairs causes them to initiate electrical impulses that are relayed by the auditory nerve to the brain. The ability to recognize pitch is based on the fact that cells stimulated by low frequencies occur at the apex of the cochlea, whereas those stimulated by high frequencies occur at the base of the cochlea. Nerve impulses from each region along the basilar membrane are relayed to slightly different regions of the brain, and the sensation of pitch depends on which area of the brain is stimulated.

Loud sounds more intensely stimulate hair cells, causing more impulses to be transmitted per unit time to the brain. This increased transmission is interpreted as loudness.

ear disease Diseases of the ear include various types of infection by bacteria and fungi; TINNITUS, which is a sensation of noises in the head or ears; rupture (puncture) of the eardrum; MENIERE'S DISEASE, which involves episodes of severe dizziness (vertigo), tinnitus, and hearing loss; otosclerosis, or abnormal bony growths of the inner ear bony capsule; and various types of complete or partial DEAFNESS (see also HEARING AID).

Middle-Ear Infections. The most common ear infections are middle-ear infections (otitis media). The middle ear is located behind the eardrum and connected to the throat by the eustachian tube. Bacteria may therefore ascend to the middle ear from the throat when infections occur there, or they may also enter through a perforation in the eardrum.

Acute middle-ear infections are accompanied by intense, stabbing pains. Antibiotics such as erythromycin and ampicillin are used to clear up such disorders. If untreated, the infections may become chronic. Such infections may also be associated with allergies, tuberculosis, measles, and other diseases. Their primary symptom is chronic drainage, or a "running ear," which usually is painless but may be accompanied by a ringing sensation in the ear. A draining ear is a warning to consult a physician promptly. It must be kept dry and clear, and it is especially dangerous for the patient to go swimming. Chronic infections are also treatable by antibiotics.

The primary danger in middle-ear infections is that complications may occur. Pus trapped in the middle ear may enter the mastoid process, the bony area that can be felt behind the external ear. From there it may spread to the inner ear, causing some degree of deafness. It may even reach membranes that cover the brain, causing MENINGITIS and possible death.

Young children, with shorter and straighter eustachian tubes than adults, are especially prone to middle-ear infections. The tendency is also apparently inherited. Fluid buildup in the inner ear is often treated by a small eardrum incision (myringotomy) to permit draining; the incision soon closes. Children may have tubes inserted through such incisions to permit draining. The tubes usually stay in place for a few months, during which time the ears must be kept out of water. Some physicians urge caution in resorting to this technique, however, because it can lead to complications.

Outer-Ear Infections. Boils in the outer-ear canal are usually a result of infection by STAPHYLOCOCCUS bacteria. An infection often occurs through a break in the skin caused by using foreign objects to relieve itching. Boils are painful, the ear may swell, and the infection may spread to the middle ear. A physician may have to incise and drain the boils and may prescribe antibiotics.

Fungal infections of the outer ear also occur. They are sometimes called "swimmer's ear," because dampness is favorable to fungal growth. Such infections are treatable by various medications, on the advice of a physician.

Ruptured Eardrum. The eardrum may be perforated, or ruptured, by shattering blasts or sharp objects as well as by infection. It may be difficult, however, to diagnose a punctured eardrum. Blood may ooze from the injury, but the same symptom may be present in a skull fracture. Sharp pain, dizziness, ringing sounds, and headaches may also accompany the puncture; it may heal without symptoms. A healed puncture may never cause future trouble; on the other hand, complications may arise. A skin-grafting operation can be performed to close those punctures which do not naturally heal.

Otosclerosis and Meniere's Disease. The ringing, roaring, clicking, or hissing sounds heard with tinnitus are actually warning signs of such diseases as infection, Meniere's disease, and otosclerosis, or they may be caused by hard masses of wax in the ear; a stuffy nose; such drugs as quinine antibiotics, aspirin, and alcohol; or excessive smoking. Noise resembling that of a roaring ocean is characteristic of Meniere's disease, but a low-pitched buzzing sound may indicate otosclerosis. Otosclerosis can cause hearing loss if the abnormal bone-growths interfere with the stapes, which conduct sound waves from the eardrum to the inner ear.

Otosclerosis is usually first detected in teenagers and young adults. Heredity seems to be an important factor in most cases; infections are not a cause. The chief symptom is slow but progressive hearing loss. The disorder is often correctible with hearing aids, but in some cases surgery may be advised. The operation does not stop the progress of the disease, but hearing may be restored for long periods of time.

Earhart, Amelia [air'-hart] Amelia Mary Earhart, b. Atchison, Kans., July 24, 1898, was the first woman to make a solo flight over the Atlantic Ocean. She recorded many other firsts in aviation history as either pilot or copilot. Earhart's solo transatlantic flight from Newfoundland to Ireland in 1932 gained her great fame. In July 1937, as she attempted the first round-the-world flight via the equator with navigator Frederick J. Noonan, her plane mysteriously disappeared after takeoff from New Guinea. A massive search for Earhart and Noonan failed. Their fate became the subject of unending speculation.

earl see TITLES OF NOBILITY AND HONOR

earless monitor The earless monitor, or Bornean lizard, *Lanthanotus borneensis*, is a snakelike lizard and the sole representative of the family Lanthanotidae, one of three lizard families from which snakes probably evolved. The earless monitor is extremely rare and has been found only in Sarawak, on Borneo. The species has a body about 40 cm (16 in) long, a neck as thick as the rear of the head, and small body scales, with enlarged scales in rows on the back and the tail. Features the earless monitor has in common with the snake are a highly protrusible and forked tongue, a solid bony brain case, no external ear, and an inability to regenerate the tail. The lower eyelid has a transparent scale, believed to be the antecedent of the window that covers the eye of all snakes.

Early, Jubal A. Jubal Anderson Early, b. Franklin County, Va., Nov. 3, 1816, d. Mar. 2, 1894, was a Confederate general in the U.S. Civil War. He graduated from

Jubal Early, one of the Confederacy's most audacious field commanders, led a daring raid on Washington, D.C., in 1864, striking within sight of the Capitol. Although Early was soon forced to withdraw, the operation panicked the citizenry and embarrassed the Union military.

West Point in 1837 but soon resigned (1838) from the army to study law. A Whig, he held several local offices, and in 1861 he opposed the secession of Virginia. Entering the Confederate army as a colonel, Early fought in most of the major battles in the east and won rapid promotion. His successes led to his selection in May 1864 to command Confederate forces in the Shenandoah Valley. In July he led a daring raid to the outskirts of Washington, D.C. He was subsequently defeated by Philip SHERIDAN at Winchester and Fisher's Hill (September) and Cedar Creek (October). When his badly outnumbered men were overwhelmed at Waynesboro (March 1865), he was relieved of command.

After the war he fled to Mexico and then lived in Canada before resuming law practice in Virginia in 1869. Early became the first president of the Southern Historical Society.

Early Bird see COMMUNICATIONS SATELLITE

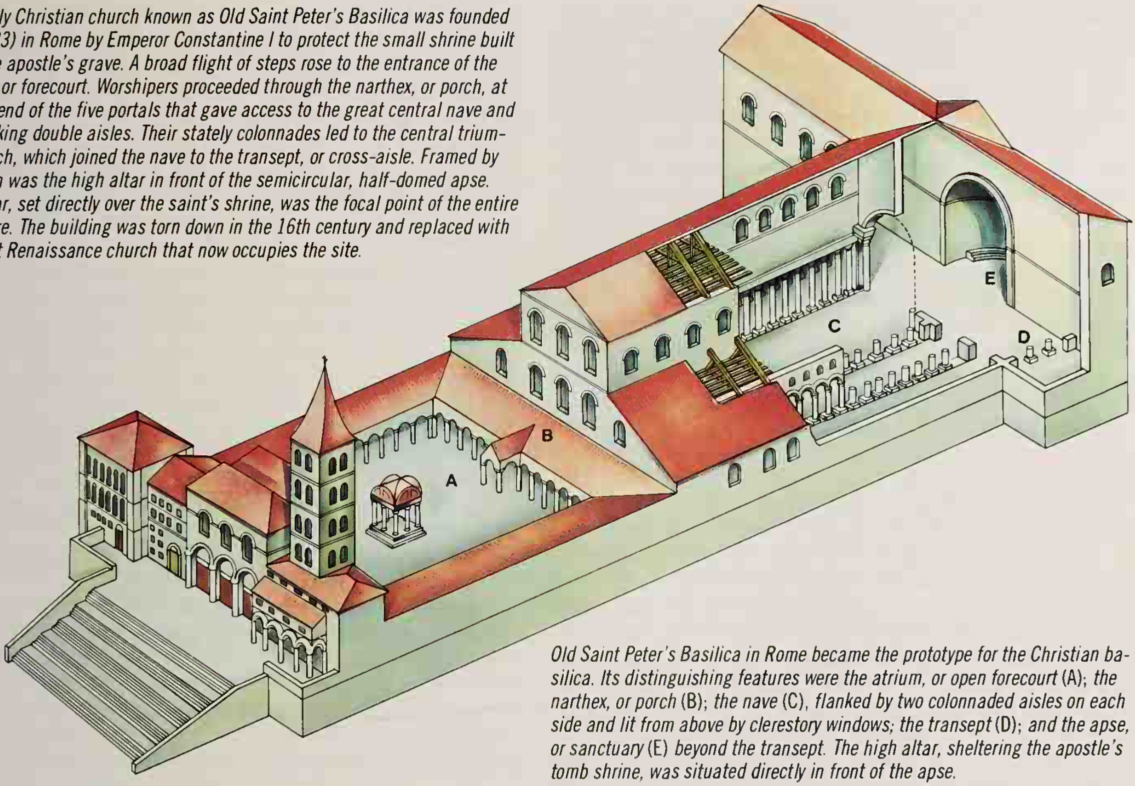
Early Christian art and architecture Early Christian art and architecture is the term used for Christian art produced between the 3d and 7th centuries, primarily in Italy and the western Mediterranean. From the mid-4th century onward, Early Christian art was closely related to the tradition of BYZANTINE ART AND ARCHITECTURE in the eastern Mediterranean and centered in Constantinople (now Istanbul). Christianity, because of the Old Testament stricture against graven images (Exod. 20:1-5), at first regarded the depiction of religious images as idolatrous. Yet it overcame this reservation and, as indicated by the mural cycle of baptismal scenes in the Christian meeting house at DURA-EUROPOS in Syria (*c*.240-50; excavated 1930s; now in Yale University Art Gallery, New Haven, Conn.), established a pictorial tradition by the 3d century. The historical turning point came in 313 with the Edict of Milan, with which Roman Emperor Constantine I recognized Christianity as an official state religion; under him and his successors the first major projects of Christian art were executed.

Representational Art. Early Christian art borrowed most of its formal vocabulary from ROMAN ART, the need to visualize the spiritual doctrines of Christianity led to the invention of a Christian ICONOGRAPHY in which the artistic image became a symbol for a religious concept or theme: the CROSS, for example, symbolized both Christ and the redemption of humankind through Christ's crucifixion. There was a corresponding emphasis on narrative art, which used pictures to recount biblical and Christian events for a largely illiterate populace.

The growing popularity during the 3d and 4th centuries of mystery religions like Mithraism and Christianity (both of which promised salvation, resurrection, and an afterlife) indicates the general shift during that period from the physical and worldly to the spiritual and divine. Similarly, late ancient art as a whole—whether secular or religious—tended toward a more abstract style of representation. Yet the transition from the pagan and classical culture of ancient times to the new Christian culture was a gradual process: these two cultures continued to coexist until the 7th century, and Early Christian art itself both preserved and revived the subjects and styles of classical art.

Architecture. Before 313, Christian places of worship were often located in converted private dwellings called *titulae*, but the Edict of Milan and the subsequent imperial sponsorship of Christianity led to public churches built on a monumental scale in forms derived from Roman architecture. Two formal types distinguish Early Christian architecture: the longitudinal BASILICA and the centralized sanctuary. The basilica, closely modeled after

(Right) *This 3d-century fresco from the Catacomb of Priscilla in Rome is an early image of the Virgin and Child.* (Below) The Good Shepherd, *a 5th-century mosaic, depicts a young man as Christ gathering His flock. (Mausoleum of Galla Placidia, Ravenna.)*



The Early Christian church known as Old Saint Peter's Basilica was founded (AD c.333) in Rome by Emperor Constantine I to protect the small shrine built over the apostle's grave. A broad flight of steps rose to the entrance of the atrium, or forecourt. Worshipers proceeded through the narthex, or porch, at the far end of the five portals that gave access to the great central nave and its flanking double aisles. Their stately colonnades led to the central triumphal arch, which joined the nave to the transept, or cross-aisle. Framed by the arch was the high altar in front of the semicircular, half-domed apse. The altar, set directly over the saint's shrine, was the focal point of the entire structure. The building was torn down in the 16th century and replaced with the vast Renaissance church that now occupies the site.

Old Saint Peter's Basilica in Rome became the prototype for the Christian basilica. Its distinguishing features were the atrium, or open forecourt (A); *the narthex, or porch* (B); *the nave* (C), *flanked by two colonnaded aisles on each side and lit from above by clerestory windows; the transept* (D); *and the apse, or sanctuary* (E) *beyond the transept. The high altar, sheltering the apostle's tomb shrine, was situated directly in front of the apse.*

the Roman basilica, or civil assembly hall, resulted from two requirements: the need to house a large congregation, and the liturgical emphasis on the altar as the site for the Christian sacrifice (communion). The centralized type was more diverse and could have a circular, polygonal, square, or Greek-cross plan; it could function as a baptistery, a memorial or martyr's shrine (martyrium), a burial chapel (mausoleum), or even as a congregational church. The interior of these churches, particularly the nave walls and apse of a basilica and the dome of a centralized building, received rich decorative programs of FRESCO PAINTING and MOSAICS. The late-5th-century Church of Sant'Apollinare Nuovo in Ravenna contains a well-preserved example of such mosaic decoration. Above the nave arcade runs a procession of male martyrs on the south wall and of female martyrs on the north wall. Presented as types rather than individuals, these figures are placed against a symbolic gold background and organized in a flat, hieratic composition that leads down the nave to the apse. The word *martyr* literally means "witness"; the Sant'Apollinare martyrs, with wide, staring eyes, are thus symbolic witnesses to the salvation of humankind through Christ.

Manuscripts. ILLUMINATED MANUSCRIPTS, hand-written texts with painted illustrations, also became a highly developed art form. One of the most luxurious of these manuscripts is the *Vienna Genesis* (late 6th century; Nationalbibliothek, Vienna). The parchment pages are dyed purple, and on each page there is a picture to illustrate the text placed above it. Many of the illustrations use the purple page as a background and have a double-register or two-level composition; the figures depicted are in the naturalistic style of classical painting. The *Vienna Genesis* demonstrates how classical art was both preserved and transformed by Early Christian art.

Sculpture. Freestanding SCULPTURE is rare in Early Christian art, in which relief sculpture was preferred, with figures carved against a solid ground (see BAS-RELIEF). An early example is the marble SARCOPHAGUS of the Roman consul Junius Bassus (*c.*359; Vatican Grottoes, Rome), with its double frieze of figures grouped in small architectural niches. Sculpture is also represented by the immensely popular relief carvings of ivory (see IVORY AND IVORY CARVING). These ivories were frequently used as diptychs (two separate panels hinged together) or for the decoration of liturgical objects, such as RELIQUARY caskets.

Earp, Wyatt [urp] Gambler, saloonkeeper, and sometime lawman, Wyatt Benny Stapp Earp, b. Mar. 19, 1848, d. Jan. 13, 1929, won fame as a gunfighter in the American West. He was born in Illinois and after the Civil War worked as a teamster, buffalo hunter, and policeman in Missouri and Kansas. In 1880, Earp arrived in Tombstone, Ariz., with his brothers Virgil and Morgan and his friend John "Doc" Holliday. There they became involved in a dispute, probably based on political and personal animosity, with the Clanton family, and in a famous gunfight at the OK Corral on Oct. 26, 1881, Billy Clanton and Tom and Frank McLaury were killed. In the vendetta that followed, Morgan Earp was murdered and Wyatt killed three men in retaliation.

Earth The Earth is a planet (see PLANETS AND PLANETARY SYSTEMS), a celestial body that revolves around a central star. It is one of the nine known planets revolving around its star, called the Sun (see EARTH, MOTIONS OF), along with a multitude of smaller objects. The system as a whole is known as the SOLAR SYSTEM.

Among the planets, the Earth is third closest to the Sun. The Earth-Sun distance, about 149,600,000 km (92,956,000 mi) on the average, is used as a unit of measure by astronomers and is known as the astronomical unit. Like all celestial objects, the Earth has a gravitational field (see EARTH, GRAVITATIONAL FIELD OF), and like most other planets it also displays a magnetic field (see EARTH, GEOMAGNETIC FIELD OF).

The Earth is accompanied by an orbiting companion, the MOON, that is smaller than the Earth but is large enough for many astronomers to consider the Earth and Moon a double-planet system. The Earth's own diameter at its equator is about 12,800 km (7,900 mi; see EARTH, SIZE AND SHAPE OF). This makes it only fifth in order of size among the planets. It is the largest of the inner planets, however, which all resemble each other to some degree in structure and composition (see EARTH, STRUCTURE AND COMPOSITION OF). By studying the materials of which the Earth is made, scientists have been able to trace its history through GEOLOGIC TIME (see also EARTH, GEOLOGICAL HISTORY OF). The many fields of scientific pursuit that make up such studies are known collectively as the EARTH SCIENCES.

See also: WORLD.

Earth, geological history of It is known that the history of the Earth spans a period of more than 4 billion years, although how the Earth formed is still a matter of speculation. Some experts suggest that it originated from condensing gas and dust. Others regard it as having developed from a cloud of meteorites and meteoric dust revolving around the Sun. Gravitational forces caused the particles to come together, or accrete, with heavier particles gravitating to the center and lighter ones collecting outside. This contraction of the mass generated heat, which caused melting and the gradual development of three layers: core, mantle, and crust.

Geologic history began when the crust first formed, about 4.6 billion years ago, as determined by RADIOMETRIC AGE-DATING of the oldest rocks and of meteorites. This event must have been preceded by a considerably longer period of astronomical history during which the SOLAR SYSTEM and, before that, the universe were created (see COSMOLOGY).

Geologic history is divided into four main eras. The first, the Precambrian Era, began 4.6 billion years ago and includes the first 4 billion years of geologic history, about 85 percent of all GEOLOGIC TIME. The second, the Paleozoic Era, lasted from 600 to 225 million years ago, roughly 10 percent of geologic time. The third, the Mesozoic Era, lasted from 225 to 65 million years ago, about 4 percent of geologic time. The fourth, the Cenozoic Era, embraces the last 65 million years, only about 1.5 percent of geologic time. Being the most recent, the Cenozoic is best known. The landscapes and life forms of modern times reached their present expression during this era.

Precambrian Era

Precambrian events occurred in four principal episodes. During the first, the primitive crust was formed. This first crust was perhaps only hundreds of meters thick. Gradually, the crust thickened, partly by continued cooling but chiefly by accretion, a result of the gravitational rise of masses of light, molten rock similar to GRANITE. About 250 million years after it had first formed, the crust was cool enough to accept rain, running water, and primitive seas.

The Earth now entered into the second stage of its development, with the advent of primitive seas, drastically different in composition from the seas that later formed, and the appearance of the first organisms, simple, one-celled life, presumably in those seas.

The third stage began with the advent of atmospheric oxygen, produced by PHOTOSYNTHESIS of sea plants (algae). Much of this gas was consumed by combining with mineral matter, especially iron. Oxidation of iron (rusting) produced the iron-bearing formations so characteristic of this stage of the Precambrian both in Europe and North America. As additional oxygen became available, carbon

Almost the entire coastline of Africa is visible in this photograph of the Earth taken during the Apollo 17 *mission. Also seen are Madagascar, the large island off the southeastern coast of Africa, and the Arabian Peninsula, at the northeastern edge of the same continent.*

dioxide was transported to the seas, and the first carbonate rocks, LIMESTONES, were formed. Organisms evidently were abundant, but the life forms still were primitive. This oxygen-developing stage may have lasted 3 billion years.

Crustal thickening and mountain building continued during the fourth stage of the Precambrian, as did deposition of SEDIMENT in the seas. The continental crust, which by this time was almost as thick as it is at present, consisted of at least five segments, or plates, each having a core of Precambrian rocks (see PLATE TECTONICS). These rocks extended outward to form a stable platform on which younger, thin SEDIMENTARY ROCK formations were deposited. The outer edges of the platforms were structurally unstable and developed linear troughs (GEOSYNCLINES), which were invaded by saltwater seas such as the one, called Tethys, that is ancestral to the Mediterranean. These conditions began about 1 billion years ago and persisted through the last 400 million years of the Precambrian, through the Paleozoic, and into the Mesozoic.

Paleozoic Era

The transition from Precambrian to Paleozoic history is marked in the FOSSIL RECORD by the sudden appearance of abundant marine fossils, hard-shelled invertebrate animals preserved in sediments. All the great groups of marine invertebrates are represented in the Paleozoic fossil record, whereas no fossil shells have been found in Precambrian rocks. The complex physiology of these animals indicates that a long period of evolution of soft-bodied invertebrate animals took place during the late Precambrian. The sudden development of hard shells may have resulted from a change in the chemistry of the oceans. Most of the first hard parts of the organisms seem to have been composed of chitin, like the horny coats of many insects and lobsters. Shells of calcium carbonate are found early in the fossil record, however, perhaps indicating that the ocean's carbon dioxide content reached some critical level that enabled animals to utilize it.

Other new species of animals and, later, of plants appeared during the Paleozoic. The first vertebrates, fishes, are found in Paleozoic rocks of Ordovician age. Amphibian fossils appear in rocks of the middle Paleozoic and reptiles in later formations. Land plants, related to the ferns, also developed during the middle Paleozoic, and in late Paleozoic time they formed extensive forests in swamps. Their woody deposits gave rise to the extensive

The geological history of the Earth is divided into four eras: the Precambrian (ending about 600 million years ago), the Paleozoic (600 million to 225 million years ago), the Mesozoic (225 million to 65 million years ago), and the Cenozoic (65 million years ago to the present). Geological processes have yielded an Earth surface comprised of strata originating from all four eras.

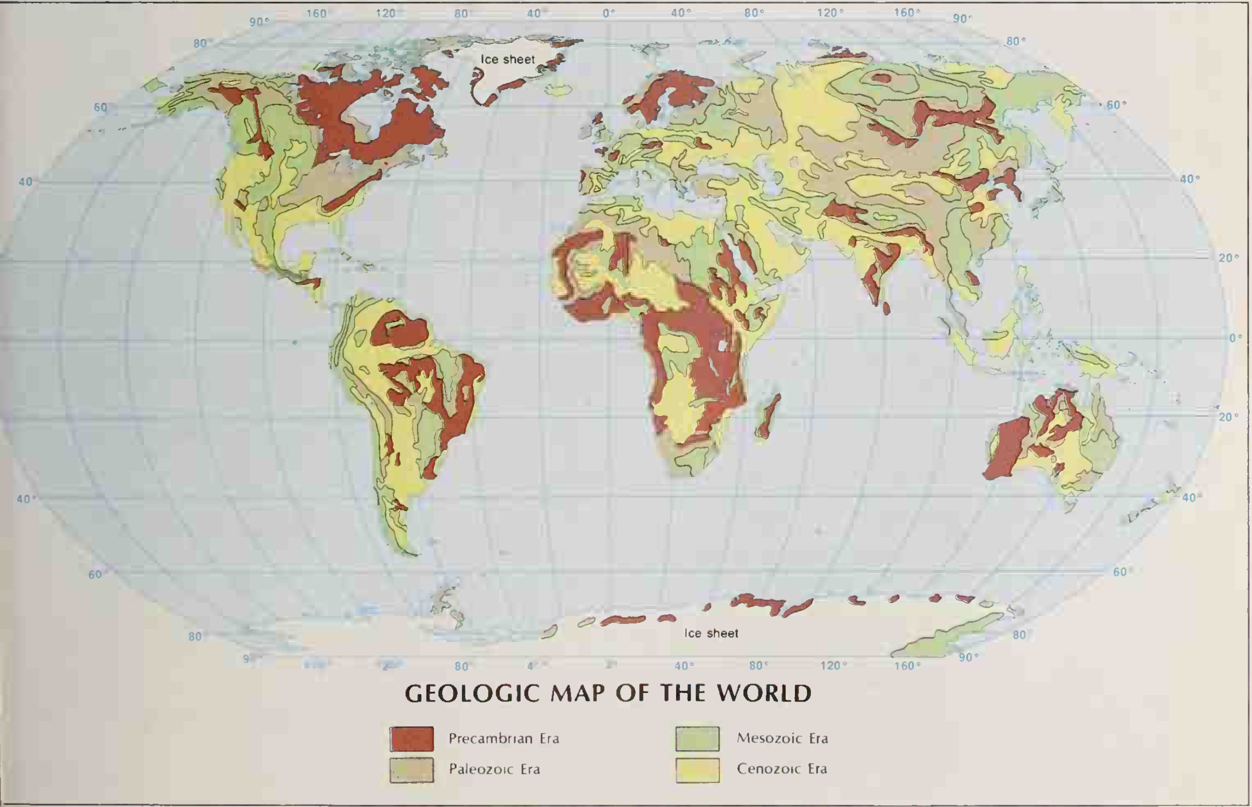


TABLE OF EARTH HISTORY

Geological Events	*Biological Events*	*Epoch*	*Period*	*Date (millions of years ago)*	*Era*	*Eon*
Precambrian Time The Earth and other planets of the solar system began as spinning balls of gases and solids, perhaps 5 billion years ago. The crust of the Earth solidified about 4.6 billion years ago, and the oldest rocks known are about 4 billion years old. Earth's early atmosphere was devoid of oxygen, and the seas that developed in the first billion years were without life. How life arose is not yet known, but the earliest fossil traces of life date from 3.5 billion years ago. The bacterialike cells are advanced enough to indicate that evolution must have begun still earlier. The geologic time period prior to the appearance of solid, shell-like fossils about 600 million years ago is known as Precambrian time, by far the longest unit of Earth history. During this period the major continental masses formed and began to drift, several ice ages took place, and the mysterious Ediacaran fauna arose, expanded, and disappeared.				5,000		ARCHEAN
				2,500	X	PROTEROZOIC
				1,600	Y	
				800	Z	
Continental drift led to formation of the supercontinent Gondwanaland. It included most of modern South America, Australia, Antarctica, Africa, Madagascar, Arabia, and India. Other continental fragments lay some distance away from Gondwanaland across the ancient Theic Ocean.	By the end of the Cambrian all the animal phyla known today were represented, except perhaps for bryozoans and vertebrates. Seas abounded with trilobites (arthropods) and brachiopods (shellfish). Plants higher than algae had not yet developed. Oxygen began to build up in the atmosphere.	Early	Cambrian	600	PALEOZOIC	PHANEROZOIC
		Middle		540		
		Late		520		
The ancient Iapetus Ocean, precursor of the Atlantic, began to close because of continental drift, producing the chain of Caledonian-Acadian mountains as the crust there folded and uplifted. Vast shallow seas flooded continental areas. A severe ice age occurred as the Ordovician ended.	Fossil traces of the first, unidentified land animals have been found in Ordovician rocks. The seas contained organisms such as reef-building corals and nautiloids (cephalopod mollusks). Bryozoans (moss animals) appeared, as did the vertebrates called ostracoderms (jawless fish).	Early	Ordovician	500		
		Middle		470		
		Late		450		
The proto-Appalachian mountain system continued to rise as the Iapetus Ocean grew smaller. After the late Ordovician ice age, continents were again invaded by shallow seas for long periods. Thus vast deposits of sedimentary rock developed in some areas such as ancient North America.	Sea life still predominated, but land life began to develop. Scorpions were perhaps the first such land animals, while the scorpionlike eurypterids were common in the sea. The first spore-bearing plants evolved in the Silurian, and freshwater fish fossils also date from this period.	Early	Silurian	425		
		Late		410		
As continental drift continued, the Theic Ocean between Gondwanaland and ancestral North America/Europe began to narrow. A mountain range arose along Gondwanaland's margin, stretching from South America to Australia. Many of the modern world's petroleum deposits date from the Devonian.	Because of the growing diversity of fish, including bony fish, the Devonian is known as the Age of Fishes. Mass extinctions of other sea forms occurred. Amphibians and insects developed. Spore-bearing plants diversified rapidly, covering landscapes with ferns, club mosses, and horsetails.	Early	Devonian	400		
		Middle		370		
		Late		360		
Ancestral North America/Europe collided with Gondwanaland. The ancient mountain chains known as the Hercynian system and the Ouichita-Appalachian-Mauritanian rose further. A series of glaciations took place as the period closed, and vast swamps led to the formation of coal beds.	Vertebrate land life established itself with the appearance of the first reptiles, whose amniote eggs enabled embryos to develop on dry land. Conifers appeared as well. In the seas, sharks were dominant life forms. Ammonoid cephalopods arose, but the trilobites approached extinction.	Early	Carboniferous	345		
		Late		320		
The Paleozoic Era ended as consolidated continental fragments formed a more northerly supercontinent called Laurasia, which joined with Gondwanaland to become the single supercontinent called Pangea. By the close of the era, ancestral China had begun to separate from this body.	Land forms continued to diversify rapidly, especially insects and reptiles, and early mammallike reptiles appeared that would give rise to mammals. A mass extinction of life forms occurred in late Permian seas, perhaps due to a loss of shallow-sea areas as supercontinent Pangea developed.	Early	Permian	280		
		Late		240		
				225		

TABLE OF EARTH HISTORY

Eon	*Era*	*Date (millions of years ago)*	*Period*	*Epoch*	*Biological Events*	*Geological Events*
PHANEROZOIC	MESOZOIC	225	**Triassic**	**Early**	The Mesozoic Era as a whole is called the Age of Reptiles. Crocodilian forms were dominant in the Triassic, but the first dinosaurs appeared, as did flying reptiles called pterodactyls and fishlike reptiles called ichthyosaurs. As the period ended the first, egg-laying mammals arose.	Pangea's breakup increased with separation of fragments that would become Indonesia, India, and Persia. The Indian Ocean also began to develop. Mountain building in the Triassic was minor and was mainly the result of the collision of island arcs and oceanic crustal plates with continents.
		215		**Middle**		
		205		**Late**		
		190	**Jurassic**	**Early**	Dinosaurs, including the largest land animals ever known, dominated the period. The modern lizard goups also developed, as did the first birds—the latter almost certainly evolving from some small bipedal dinosaur. Mammals remained insignificant. Bivalve mollusks evolved in the oceans.	Ancestral Australia/Antarctica separated from Pangea, and the ancestral basin of the North Atlantic appeared as North America/Europe moved away. Shallow seas expanded and retreated. Growing mountain chains included the Andes, Sierra Nevada, Caucasus, and mountains of New Zealand.
		170		**Middle**		
		160		**Late**		
		135	**Cretaceous**	**Early**	Late dinosaurs included highly advanced, herding forms. Landscapes took on a more modern look as flowering plants developed. The era ended with some great catastrophe that led to mass extinctions and brought the reign of the dinosaurs to an end. An asteroid collision has been suggested.	By the end of the Mesozoic, Pangea did not exist, and continents began to bear some resemblance to their present form. The Cretaceous exhibited extensive volcanism and mountain building. The Himalayan and Middle Eastern ranges took early shape, as did the Rocky Mountains of North America.
		100		**Late**		
	CENOZOIC	65	**Tertiary**	**Paleocene**	The Cenozoic is called the Age of Mammals because mammals quickly evolved to fill in ecological niches vacated by the dinosaurs, although in very early years giant birds may have been the dominant carnivores. The placental mammals began to outnumber the marsupials. Early in the era the first recognizable ancestor of the modern horse appeared. Gigantic brontotheres evolved in the Oligocene Epoch, only to disappear as the growth of extensive prairies came to favor more lightly built animals.	The first three epochs of the Tertiary are sometimes collectively referred to as the Paleogene. (The remaining epochs, on up to the present, are then referred to as the Neogene, but they are treated separately below.) Over this time span, the pattern of ocean circulation worldwide took on its modern form as the Arctic and Atlantic became linked and the distance between South America and Antarctica widened. As the African and Eurasian plates collided, the Pyrenees, Alps, and Himalayas grew.
		54		**Eocene**		
		38		**Oligocene**		
		26		**Miocene**	Among the prominent mammals of the epoch were the mastodon and saber-toothed cat. Among the primates, the Miocene was also notable for the appearance of great apes.	By Miocene times, the Atlantic had reached approximately its present width. India collided with and joined Asia, adding to the ongoing uplift of the Himalayas.
		12		**Pliocene**	With the cooler climates that heralded the coming ice ages, many mammal forms became extinct. The ape *Australopithecus* arose, regarded as ancestral to the human race.	Land connections between North and South America and between Africa and Eurasia were reestablished, and the Great Rift Valley system of Africa began to develop.
		1.7	**Quaternary and Recent Time** The Quaternary, the most recent of the geological periods, is usually divided into two epochs: the Pleistocene, beginning about 1.7 million years ago, and the Holocene, or Recent time. This last epoch dates from about 10,000 years ago, the time of the most recent retreat of the ice sheets that periodically advanced and retreated during the course of the Quaternary. No other striking worldwide geological changes set off this time division from the Tertiary. What makes these most recent epochs crucial to Earth history is that in their course the human race appeared and civilizations developed, with major ecological consequences. The results of human activities are profoundly affecting the environmental systems of the planet as a whole. Whatever the future course of life on Earth, the planet itself should survive for several billion more years. In time, however, the dying Sun will briefly expand as a red giant star, consuming the planet Earth.			

coal beds (see COAL AND COAL MINING) that characterize the Carboniferous Period, or late Paleozoic.

The geosynclinal troughs, ancient seas in which marine deposits accumulated, persisted through the Paleozoic, although with interruptions, until about 12,000 m (about 40,000 ft) of sediment had accumulated in them. The ancient seas that occupied these troughs were rather shallow, and such great thicknesses of sediment could not have been deposited if the troughs had not gradually sunk as the sediment accumulated.

Toward the end of the Paleozoic the sides of the geosynclines were squeezed together by lateral movements in the crust (see PLATE TECTONICS), and the sediments, originally soft and wet, became consolidated into rock, uplifted, folded, and faulted. From these movements, mountains such as the APPALACHIANS slowly grew.

The crustal plates, constantly in motion, brought all the world's landmasses together into one supercontinent (Pangaea) toward the end of the Paleozoic. They were not to come apart again until the Mesozoic, when present-day continents took shape. Moreover, the ancestral supercontinent was located in the Southern Hemisphere, far removed from the area of greatest concentration of present-day landmasses. This is borne out by the fact that late Paleozoic coal deposits at temperate latitudes in Europe and North America contain evidence of tropical conditions, whereas correlative formations just south of the equator in Africa and South America contain evidence of continental glaciations.

Mesozoic Era

The flora and fauna preserved in Mesozoic rocks are wholly different from those of the Paleozoic. In addition to the DINOSAURS, which are so characteristic of the era, the first birds appeared, and mammals, although small, thrived and became increasingly abundant. Among the plants, CONIFERS were dominant during the first part of the era; flowering plants, including broadleaf trees similar to modern ones, appeared later in the era. Sea life was characterized by modern forms of corals, clams, and other kinds of shellfish, although the species differ from those of the Paleozoic. The ancestral supercontinent, Pangaea, began to break up by about the middle of the Mesozoic (see CONTINENTAL DRIFT). As a result, certain species of terrestrial mammals became isolated in such widely separated places as Antarctica, South America, Africa, and Australia.

In the oceans, drifting of crustal plates that began during the middle Mesozoic created linear depressions (see OCEANIC TRENCHES) analogous to geosynclines. Volcanic ridges (see MID-OCEANIC RIDGE) developed on the seafloor where viscous mantle rocks broke through the oceanic crust. The oceanic crust has spread laterally from these ridges, and as a result crustal rocks are progressively older away from the ridges (see SEAFLOOR SPREADING). At the trenches, crustal rocks are being shoved oceanward. At the Aleutian Trench, for example, along the south side of the Aleutian Islands, continental rocks are being shoved southward into the Pacific. This structural activity is marked both by volcanism and by EARTHQUAKES.

Cenozoic Era

At the end of the Mesozoic and the beginning of the Cenozoic, several of the world's greatest mountain chains were uplifted—the Rockies and Pacific Coast Mountains in North America, the Andes in South America, the Alps and other mountains bordering the Mediterranean Sea, and their eastward extensions, including the Himalayas of northern India. In the middle Cenozoic, the movement of crustal plates began to break some continental areas into fault blocks, notably in the western United States and Mexico. Continued crustal movement created the RIFT VALLEYS of Africa, which extend northward to the Red Sea, Dead Sea, and Jordan Valley. The Pacific RING OF FIRE, the Cenozoic structures of the Mediterranean-Himalaya belt, the block-faulted areas, and the rift zones are all sites of extensive modern volcanism and earthquake activity.

The FOSSIL RECORD of Cenozoic rocks reveals the EXTINCTION of the dinosaurs and the ascendancy of the mammals. Few Mesozoic species survived into the Cenozoic, so another major paleontological discontinuity separates the eras. Cenozoic fossils serve as good examples of evolution among some of the vertebrates, notably the horse, for which a complete fossil record exists.

The last 2.5 to 3 million years of the Cenozoic, known as the Pleistocene Epoch, is sometimes called the Age of Man. The earliest dated hominid skeletal remains are found in the rift valleys of Africa. From there, humans migrated to the other continents and evolved to the species *Homo sapiens* that dominates the world today (see PREHISTORIC HUMANS). During the last million years of the Cenozoic, human ancestors in Europe and Asia experienced five periods of glaciation. During the ICE AGES polar ice caps spread onto the continents—halfway to the Mediterranean in Europe and halfway to the Gulf of Mexico in North America—but humans apparently did not arrive in North America until the last glaciation (see GLACIER AND GLACIATION). The last retreat of the ice sheets, at the close of the Pleistocene Epoch, 10,000 years ago, was accompanied by a worldwide rise in SEA LEVEL of several hundred meters that flooded low-lying regions and greatly extended the CONTINENTAL SHELF in areas such as the Atlantic.

Earth, geomagnetic field of The Earth has a magnetic field, which originates primarily within the Earth's interior, although a small part is produced by the planet's IONOSPHERE and MAGNETOSPHERE. About 90 percent of the geomagnetic field can be represented as that produced by a bar magnet located at the Earth's center and inclined at about an 11° angle to the Earth's rotational axis.

Distribution. At a given point on the Earth's surface, the geomagnetic field can be represented by its intensity (F); its dip or inclination (I), the downward deviation of its direction from the horizontal plane; and its declination (D), the eastward deviation of the horizontal component of geomagnetic-field vector from true north.

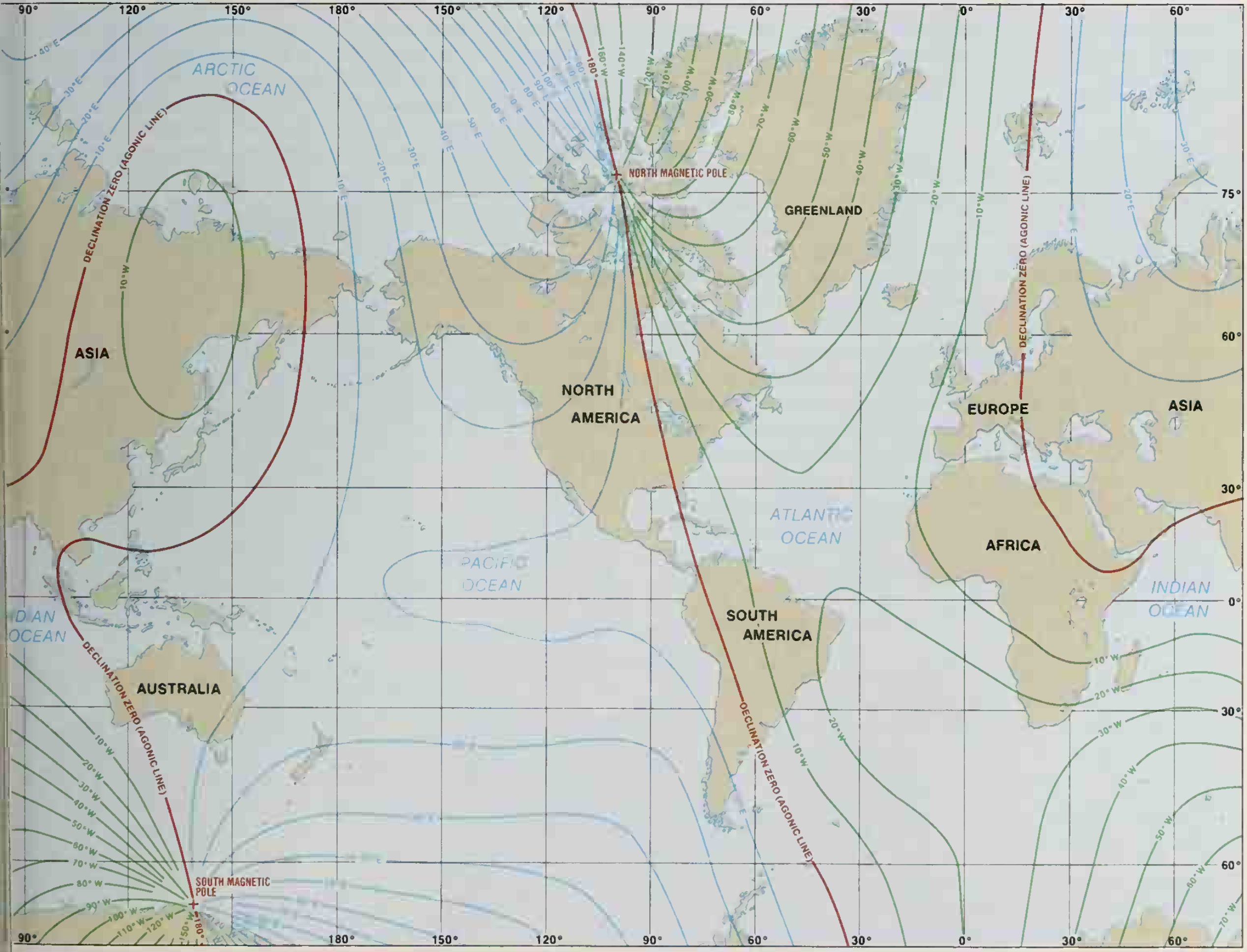
The lines of force of the geomagnetic field point vertically downward ($I = 90°$) at the north magnetic pole (76°

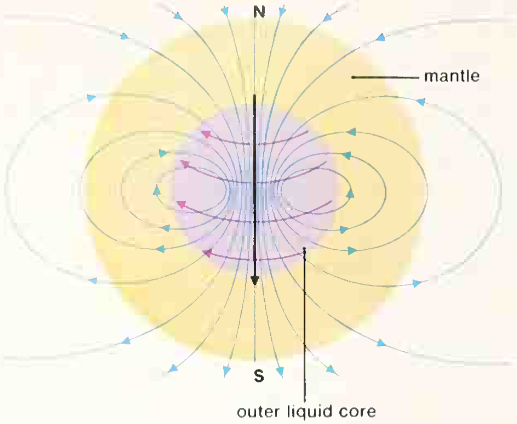
north latitude, 100° west longitude in 1975) and vertically upward ($I = 90°$) at the south magnetic pole (66° south latitude, 139° east longitude in 1975).

The geomagnetic field has been measured at many points on the Earth's surface and also, with aircraft and artificial satellites, at points above it. These magnetic surveys have revealed in fair detail the distribution of the geomagnetic field on the surface of and in the space around the Earth. They have also demonstrated that the geomagnetic field consists of, in addition to the main magnetic field, relatively small local magnetic fields that are closely related to the geological structures near the Earth's surface. For example, IGNEOUS ROCKS are much more strongly magnetized than SEDIMENTARY ROCKS; therefore, the geomagnetic field near such igneous rock bodies as volcanoes is systematically disturbed. Detailed magnetic surveys can thus often identify subterranean magnetized geologic bodies and determine their approximate structures. Geophysical research suggests that movements of the fluid rock in the Earth's outer core have resulted in irregular changes in the Earth's magnetic field (see GEOPHYSICS).

Variation. The main geomagnetic field is changing with time. Its intensity has been continuously decreasing by 6 percent every 100 years, and the magnetic poles are drifting an average of about 0.2° west per year (see POLAR WANDERING). These secular variations have been directly observed only during the last 100 years. Analysis of certain rocks, however, has revealed not only the secular variations of the geomagnetic field over a long geologic time, but also frequent complete reversals of its distribution pattern during periods of just a few thousand years

World maps of magnetic declinations, or angular deviations from true north, are used by navigators to correct compass readings observed at different locations. Lines connecting regions of equal declination, called isogonic lines, *can vary from 0° through any angle east or west of true north to a maximum of 180° in the polar areas. Lines drawn through places with zero declination are termed* agonic lines.





The dynamo theory of the Earth's magnetic field postulates that the field results primarily from rotation (red lines) *of the liquid outer core relative to the solid mantle that surrounds it. The rotary motion generates electrical currents within the predominantly iron inner core and at the same time creates a dipole magnetic field* (blue lines) *with north* (N) *and south* (S) *magnetic poles at opposite ends of the axis of rotation. It also creates a dipole moment* (black arrow). *This type of field is similar to that formed by an electric current in a wire coil.*

(see PALEOMAGNETISM). This polarity reversal is the most conspicuous characteristic of the geomagnetic field.

Dynamo Theory. A theoretical interpretation of the mechanism that produces and maintains the main geomagnetic field must explain its remarkable variations as well as its intensity and other characteristics. The most plausible theory is known as the dynamo theory. Developed by British physicists W. M. Elasser and Sir Edward Bullard, it attributes the Earth's magnetism to currents flowing inside its fluid outer core (see EARTH, STRUCTURE AND COMPOSITION OF) and to the conversion of this mechanical energy into electromagnetic energy. According to this theory, the field is maintained by the self-sustaining dynamo action of the core, which is presumed to flow in such a pattern that the electric current induced by its motion through the magnetic field sustains that field. The separate source of energy needed to move the core is generally assumed to be tidal energy or heat.

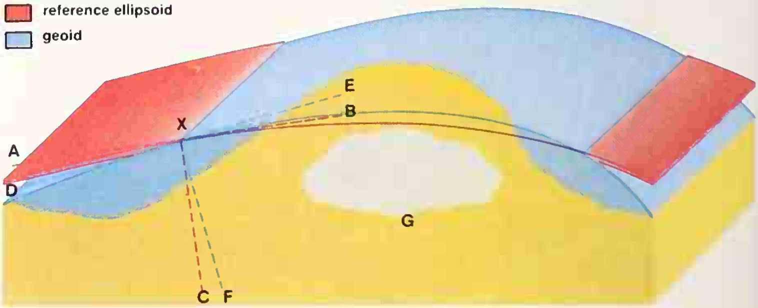
Earth, gravitational field of The planet Earth, as with any object possessing MASS, has a gravitational field (see GRAVITATION). The strength of this field is most familiarly recognized in terms of the WEIGHT that a body has, depending on its location with respect to the Earth. Its strength may also be compared with the fields of other planets in terms of the velocity that a body must attain in order to escape from those fields (see ESCAPE VELOCITY).

Strength of the Field. The overall strength of the Earth's gravitational field is determined primarily by the mass of the planet. The Earth's mass attraction accounts for more than 99.4 percent of gravity at the equator and ranges up to 100 percent at the poles. The gravitational component resulting from the Earth's mass acts in a downward direction. The force of gravity is expressed in terms of units of *acceleration* called gals, 1 gal being 1 cm/sec^2. Roughly, 980 gals (32 ft/sec^2) is the rate at which objects fall freely toward the Earth's surface.

Gravity Anomalies. In dealing with gravity measurements, scientists refer to an idealized Earth shape, the reference ellipsoid. The true shape, called the geoid, is a surface that is perpendicular to the force of gravity at every point. The geoid departs from the shape of the reference ellipsoid because of anomalous masses within the Earth, particularly in its upper 100 km (60 mi). Values of gravity on the geoid can be determined only by observation.

The spiral path that a charged particle follows in outer space as it moves across the lines of force of the Earth's magnetic field is recorded for the first time in this 1988 videotape image. The picture was made by aiming an electron beam into space. The light resulted from the beam striking molecules of the very thin air remaining at that height.

Earth's shape is represented by an ellipsoid with an equatorial diameter longer than the polar diameter. The true shape is the geoid, in which the surface is everywhere perpendicular to the force of gravity. It is an irregular curve because gravity varies with location. Thus, if a plumb bob is suspended at a point X on line AB *that is part of the reference ellipsoid* (red plane), *the direction of gravity would be expected to be line* XC *at right angles to* AB. *A nearby large mass* G *would attract the bob toward it and indicate* XF *as the direction of gravity. The geoid surface* (blue plane) *near point* X *would be along line* DE *perpendicular to* XF.



Gravity anomalies are the differences in the values of gravity on the geoid and on the reference ellipsoid. Anomaly maps thus show differences between observed gravity, reduced to its sea-level equivalent, and normal, or theoretical, gravity. Gravity on the geoid can be determined directly from gravity measurements made with a GRAVIMETER or indirectly by charting perturbations in the orbital paths of artificial satellites (see SATELLITE, ARTIFICIAL) caused by large mass anomalies within the Earth.

Earth, heat flow in Heat flows continuously from deep within the Earth to the planet's surface. The interior of the Earth is kept hot primarily by energy released from the decay of radioactive elements (see RADIOACTIVITY). The Earth was probably cold when it first formed, over 4 billion years ago. Gravitational contraction generated heat, causing the interior to melt. The temperature of the Earth's core (see EARTH, STRUCTURE AND COMPOSITION OF) is now about 4,500° C (8,100° F). On the average, temperature increases from the Earth's surface downward at a rate of about 3 C degrees (5 F degrees) per 100 m (330 ft) of depth.

Heat is transferred through the Earth by two processes. Conduction accounts for only a small amount of heat transfer because rock is a very poor conductor. Convection, on the other hand, rapidly distributes heat through fluid materials. As the heated portion of a fluid expands, it becomes less dense and rises. Cooler, denser material sinks, replacing the heated portion and thereby setting convection currents in motion.

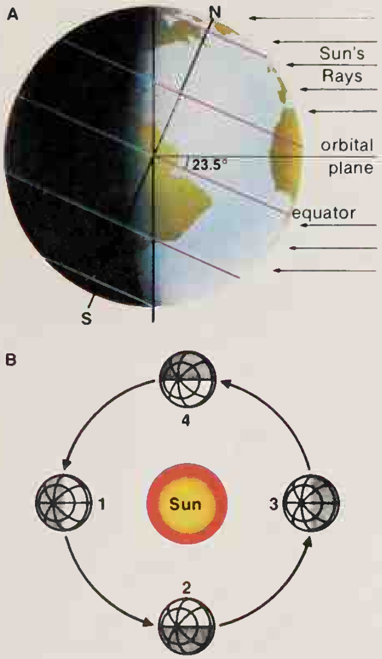
Convection currents within the Earth's mantle are responsible for movement of the large blocks of the Earth's surface called plates (see PLATE TECTONICS). The plates appear to glide on the asthenosphere, a partially molten zone, moving across the Earth's surface until they reach trenchlike zones, where they plunge into the heated interior, melt, and are recycled with new molten MAGMA in the mantle.

This process also gives rise to volcanic activity. Convective flow brings heat to the surface in the form of plumes of hot, molten rock that form "hot spots," such as the VOLCANO systems of Iceland and Hawaii.

Much of the Earth's heat is released along the great MID-OCEANIC RIDGE. Measurements reveal higher-than-normal heat flow along the rift that splits the spine of this ridge. Heat flow diminishes with increasing distance from the rift as new crust wells up in the form of molten rock, solidifies, and spreads outward (see SEAFLOOR, SPREADING).

Earth, motions of The planet Earth exhibits a number of different motions. The most familiar of these are its rotation, or spinning on an axis, and its revolution, or passage around the Sun. The Earth takes one DAY to turn once on its axis and one YEAR to complete one orbit of the Sun.

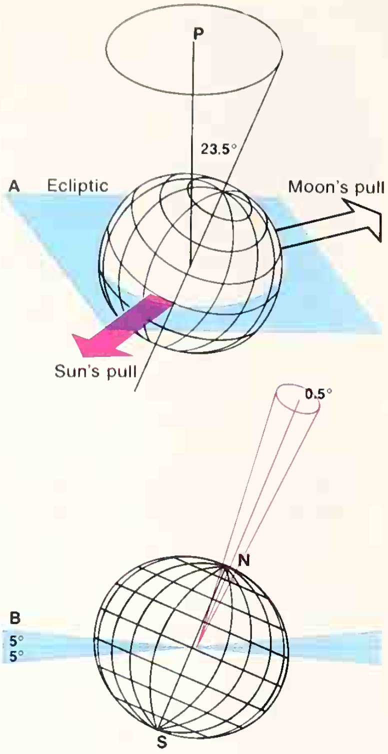
The Earth's orbit, in a plane called the ECLIPTIC, is a nearly circular ellipse with the Sun at one focus (see KEPLER'S LAWS). The Earth is nearest the Sun (perihelion) about January 3 and farthest (aphelion) about July 4 (see ORBITAL ELEMENTS). The orbital speed averages 30 km/sec (18.6 mi/sec). It is greatest at perihelion and least at aphelion. The spin axis intersects the Earth's surface at the NORTH POLE and SOUTH POLE. The great circle 90° from the poles is the EQUATOR. It intersects the ecliptic at an angle of about 23.5°, at points called the vernal and autumnal EQUINOXES. The Sun apparently passes through these points within a day or two of March 20 and September 23, respectively. The Sun is most northerly about June 21 and most southerly about December 22; in the Northern Hemisphere these events are called the summer and winter solstices.



The most important motions of the Earth are its rotation (A) and its revolution about the Sun (B). Rotation results in alternating days and nights and in an apparent daily motion of the Sun and stars across the sky. Because the Earth's equator is tilted 23.5° from the orbital plane, the Sun's altitude, and thus the seasons, change. The Sun appears farthest below the celestial equator at the winter solstice (1), on the equator at both the vernal (2) and autumnal (4) equinoxes, and farthest above the equator at the summer solstice (3).

Because of its rotation, the Earth has an equatorial bulge, upon which the gravitational attractions of the Sun and Moon act. The Earth, as a result, moves like a top. The spin axis keeps a nearly constant inclination to the ecliptic but describes a cone in space in a period of about 25,800 years. This motion is known as the PRECESSION OF THE EQUINOXES. Superimposed on this motion are small periodic effects (caused by the Moon's attraction) called NUTATION. The principal term has amplitude 9" (0.0025°) and a period of 18.6 years.

Precession and nutation are motions of the spin axis in space. The Earth itself moves (aside from pure rotation) with respect to the spin axis because of unequal mass distribution about the axis. Consequently, the geographic poles move around the Earth's shortest axis, the axis of figure. This motion, called polar motion, has two components with periods of 12 and 14.2 months; these come in and out of phase, so the pole spirals in and out. The max-



The Earth's rotational axis is not fixed in space but revolves, or precesses, in a circle of 23.5° radius about the ecliptic pole (P) *once every 25,800 years* (A). *The precession occurs because the Earth bulges slightly at the equator. The gravitational pull of the Moon and the Sun on the equatorial bulge tends to move the equator toward the ecliptic plane. The spinning Earth acts like a gyroscope and resists the torque by precessing its axis in a circle. The Moon's orbital plane, which is inclined 5° to the ecliptic plane* (B), *turns around the Earth in an 18.6-year period, causing a variation in the Moon's pull. This change results in a small periodic circle of 0.5° radius, called* nutation.

imum distance from the mean position, which is called the mean pole, is approximately 12 m (40 ft).

The mean pole has also been observed to move about 8 m (26 ft) since 1900, toward about 70° W. If this drift were to continue for long intervals, it would change latitudes considerably and affect climates in different parts of the world. The astronomical data provide no basis, however, for assuming that large changes have occurred or will occur.

The Earth, together with the Sun and the rest of the solar system, moves about 19 km/sec (12 mi/sec) with respect to neighboring stars. It also partakes of the Sun's motion as a member of The Galaxy. The Sun revolves around the galactic center at a speed of about 250 km/sec (155 mi/sec).

Earth, size and shape of The Earth is a roughly spherical body that is somewhat flattened at its poles. Its equatorial circumference and diameter are, respectively, 40,075 km (24,902 mi) and 12,756 km (7,926 mi). Its polar circumference and diameter are 40,008 km (24,860 mi) and 12,714 km (7,900 mi).

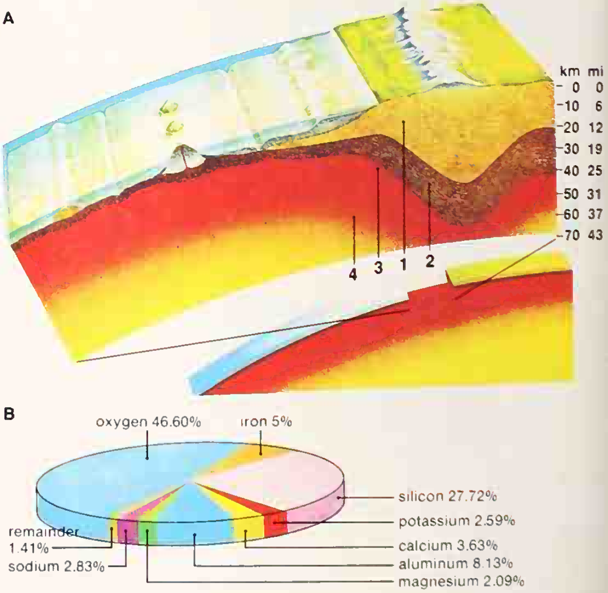
The foundations of geodesy, the science that deals with the size and shape of the Earth, were established by Sir Isaac Newton, who predicted that the Earth's shape is an oblate ellipsoid (see Earth, gravitational field of). This was confirmed when the French Academy of Sciences sent expeditions to Peru in 1735 and to Lapland in 1736. The findings of these expeditions established that the polar axis is shorter than the equatorial axis by about 1 part in 298.

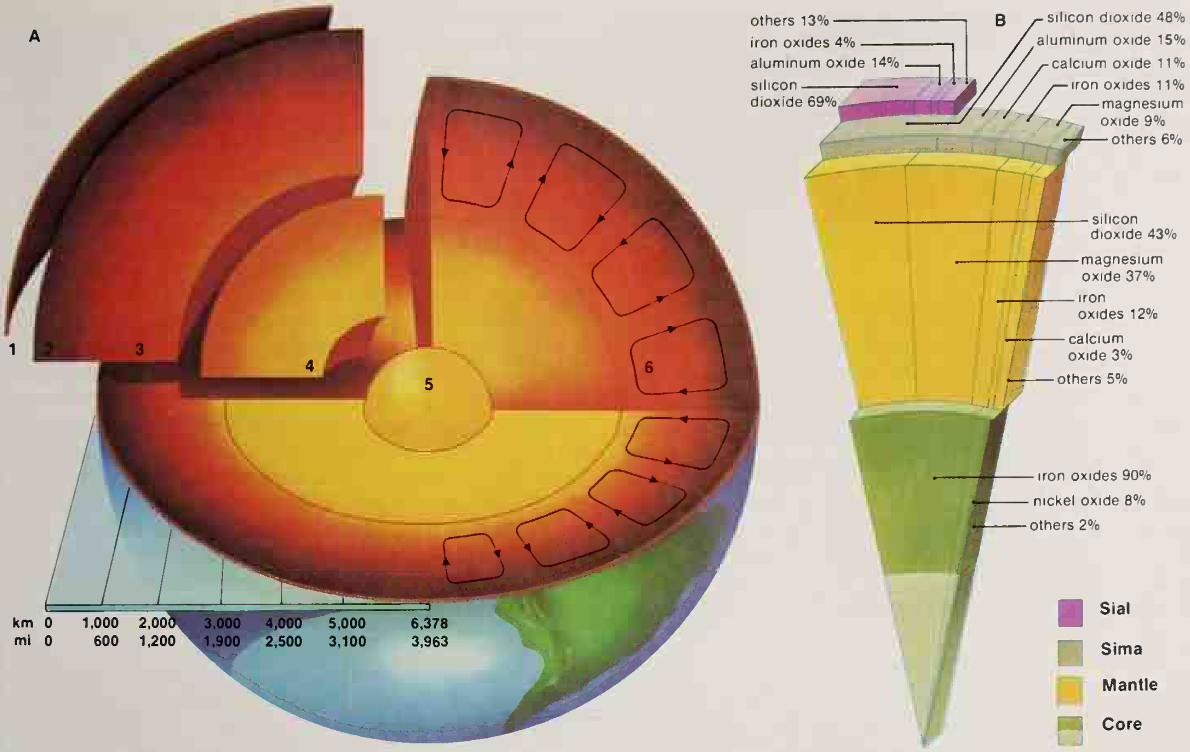
When the metric system was created, the meter was defined as 1/10,000,000 of the quadrant of the meridian from North Pole to equator. The quadrant was later found to equal 10,002,000 m (32,814,960 ft), but the meter has since been redefined in terms of the speed of light.

Earth, structure and composition of The Earth is a terrestrial planet in its structure and composition. That is, like the other inner planets of the solar system—Mercury, Venus, Mars, and the Earth's own Moon—it has an internal structure of different layers of rocky materials composed of a wide range of minerals. The other planets of the system probably all have rocky cores as well, but these cores are cloaked by massive layers of gases and are not available for comparative study (see planets and planetary systems).

Within the Earth, the decay of radioactive isotopes drives the planet's internal heat engine (see radioactivity). The heat generated by this furnace is equivalent to only about 0.046 percent of the heat received from the Sun. It nevertheless produces sufficient energy to create volcanoes and shape the Earth's surface through plate tectonics.

The crust beneath Earth's continents consists of two layers (A). *The upper layer* (1), *which is mainly composed of granite rocks, is called* sial, *an acronym that uses the first two letters from silica and alumina, its major components. The lower, denser basaltic layer* (2), *termed* sima *because it is rich in silica and magnesia, is also found under the ocean floors. The Mohorovičić discontinuity, commonly called the Moho discontinuity* (3), *links the crust and the mantle* (4). *Sial mountains have deep roots and float on sima layers like icebergs. Practically the entire crust is made up of only eight elements* (B).





Studies of seismic waves reveal that Earth is composed of several layers (A). *A surface crust* (1) *varies in thickness from about 35 km (22 mi) under the continents to 5–7 km (3–4 mi) beneath the ocean floors. A layer called the Mohorovičić discontinuity* (2) *separates the crust from a 2,900-km-thick (1,800-mi) mantle* (3), *which becomes plastic in its hot inner parts. The central region consists of a 2,200-km-thick (1,400-mi) liquid outer core* (4) *and a 2,500-km-diameter (1,600-mi) solid inner core* (5). *Convection currents* (6) *are thought to be generated in the mantle by the intense heat from the liquid core and to be responsible for continental drift. Chemical compositions* (B) *of the layers differ considerably. Rocks constituting the continental crust (sial) are primarily varieties of granite, an igneous rock formed chiefly of silicon and aluminum oxides. Beneath this layer is the oceanic crust (sima), composed of basaltic rocks, which are similar to granite but richer in magnesium oxides. The mantle consists chiefly of magnesium and iron silicates, and heavy iron and nickel oxides constitute both core zones.*

Earth's Four Shells. Although the deep interior of the Earth cannot be sampled by drilling, its structure and composition can be inferred by seismic waves generated by explosions or EARTHQUAKES. The Earth is not homogenous, but layered into a crust; a mantle; an outer, liquid core; and an inner, solid core. The crust is thin; the 2,900-km-thick (1,800-mi) mantle dominates the Earth. The outer core does not much affect events on the Earth's surface, but its fluid motion generates the magnetic field. Because these motions are generally latitudinal, the magnetic poles lie close to the axis of rotation (see EARTH, GEOMAGNETIC FIELD OF). The mantle itself reveals some secondary layering, with notable transition zones at 350- and 650-km (220- and 400-mi) depths. These discontinuities are apparently caused by phase changes in the crystal lattice of OLIVINE, the common mineral of the mantle.

The outer shell of the Earth may be further classified from the standpoint of rigidity. An outer 100-km-thick (60-mi) LITHOSPHERE, which includes both the crust and the uppermost layer of the mantle, is cool and hence strong. Beneath the lithosphere is the asthenosphere, a 100-km-thick (60-mi) zone in which rocks are weak from partial melting (see EARTH, HEAT FLOW IN).

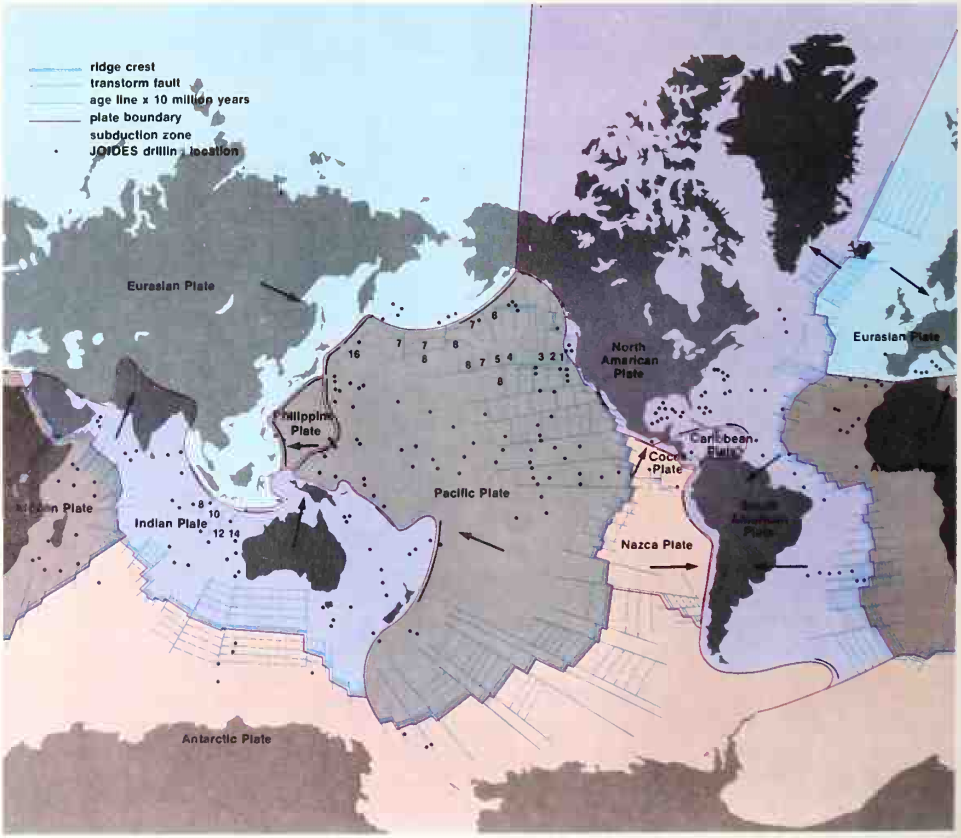
Oceanic and Continental Crust. The Earth has two types of crust. Basaltic oceanic crust, usually about 6 km (4 mi) thick, underlies the ocean basins (see BASALT). In contrast, the continental crust is composed of rocks like GRANITE and typically is about 35 km (22 mi) thick. Beneath plateaus and mountains it may be as much as 70 km (40 mi) thick. Continents and ocean basins are, of course, topographic landforms of the first order of magnitude. In both cases the sharp composition boundary between the crust and the underlying mantle is termed the MOHOROVIČIĆ DISCONTINUITY, or simply, the Moho. The continents stand high because they are composed of low-density rock. They literally float in the heavier mantle rock, supported by their buoyancy in accordance with the principle of ISOSTASY. The abrupt transition between regions of oceanic crust and continental crust is marked by the huge undersea escarpments called the continental slopes (see CONTINENTAL SHELF AND SLOPE). The differences in both relative thickness and density of the two crustal segments, resulting in a topographic contrast of about 5 km (3 mi), are expressed by the division of the Earth's surface into continents and ocean basins.

A generalized plane view of the Earth reveals the continents as layered platforms floating as islands in a single universal ocean basin. The central cores of continents contain nuclei of ancient mineral-rich Precambrian crystalline rocks—the CANADIAN SHIELD of North America, for example—with increasingly younger rocks surrounding this nucleus. These are usually coated with flat-lying marine SEDIMENTS laid down in the shallow seas that have ebbed and flooded over the aeons across the continental platforms. The margins of continents are generally the sites of active young mountain ranges. The continents have apparently grown by the process of lateral accretion of mountain FOLD belts.

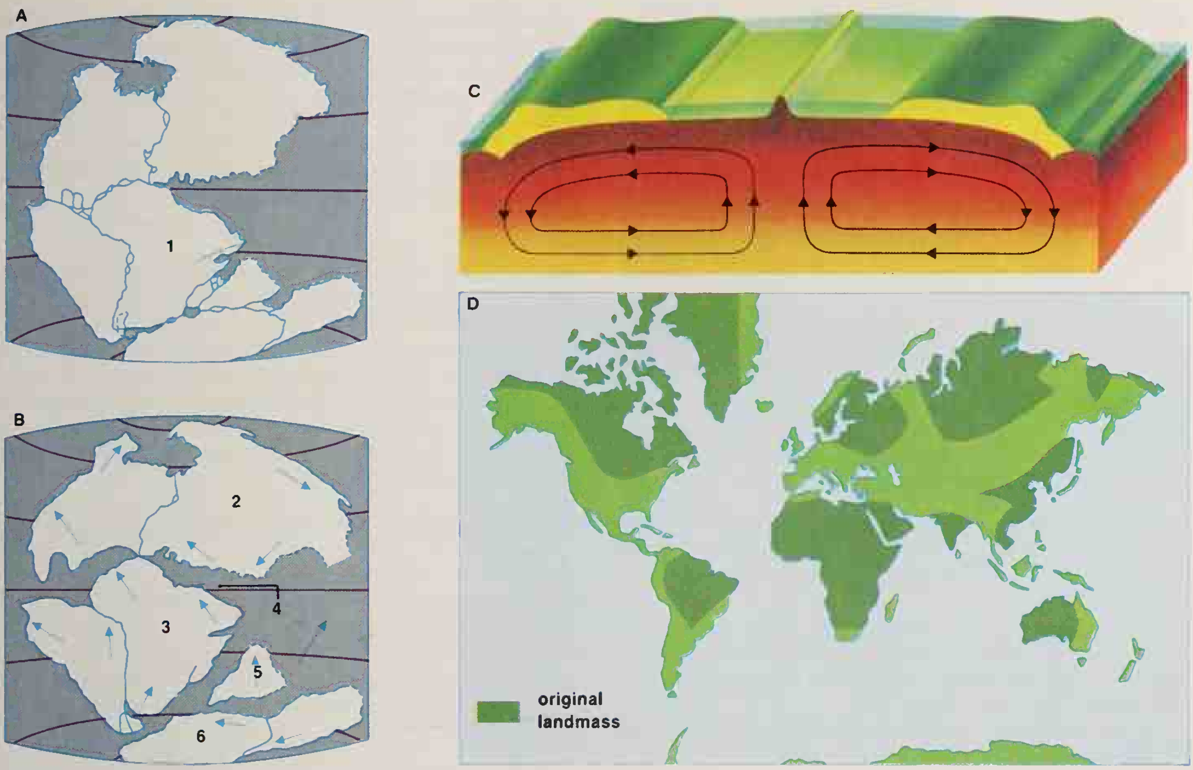
Crater Modification. In addition to the changes generated by PLATE TECTONICS, the Earth's crust also registers the effects of bombardment by asteroids and comets. METEORITE CRATERS produced by such bombardment dominate the surface of the Moon and the other terrestrial planets. Most of the impacts within the solar system occurred more than 3.8 billion years ago. The scarred surfaces of the relatively inert terrestrial planets, unlike the face of the Earth, still record this early history. On Earth, active tectonism and erosion have erased much of this record. Because most of the interplanetary debris has been swept up, the frequency of large impacts is now rather low. About three large impacts, large enough to create a crater 10 km (6 mi) or more across, occur every million years. Geologists now recognize more than 100 impact sites on the continents. Nearly all of these astroblemes, or "star scars," are deeply eroded and barely visible. A notable exception is Arizona's geologically recent METEOR CRATER.

Air and Water. The ATMOSPHERE and the HYDROSPHERE, like the shells of the Earth, are not primitive features. Both have evolved secondarily. Like the crust, they have been slowly squeezed out of the mantle. The early atmosphere did not contain any free oxygen, whose modern presence depended on the appearance about 2 billion years ago of photosynthetic algae that absorb carbon dioxide and release oxygen (see BLUE-GREEN ALGAE). Even so, oxygen levels remained low until the late Precambrian, about 700 million years ago, when levels rose to a few percent, permitting the evolution of more complex life forms.

Probably a rather large amount of primordial water was



Earth's crust is believed to be a mosaic of about 12 large lithospheric plates and several minor ones that move as rigid units. Great crustal activity occurs at three main types of plate boundaries: ridges, subduction zones, and transform faults. As new crust is generated at ridges, old crust is destroyed at subduction zones when one plate plunges beneath another and descends into the hot mantle. At transform faults one plate slides past another; thus no material is lost. Dating of deep core samples, obtained by the JOIDES group of oceanographic institutions, at different sites along the seafloor (black dots), *reveals that floor ages increase with distance from a ridge. The dotted lines on the ocean floor are lines of equal age. Where lines are numbered, the age is given in tens of millions of years.*



In 1910 a German meteorologist, Alfred Wegener, first suggested (A) *that all the continents were once joined in a single large landmass that he called* Pangaea (1), *which was surrounded by a single world ocean named* Panthalassa. *About 200 million years ago Pangaea began to break apart and after 20 million years of drift* (B) *had split into two continents,* Laurasia (2) *and* Gondwanaland (3), *separated by the Tethys Sea* (4). *Gondwanaland itself had started to break up, setting free India* (5) *and Antarctica-Australia* (6). *It is believed that thermal convection currents in the Earth's mantle* (C) *have caused the seafloor spreading and drifts that have brought the continents to their present positions* (D).

sweated out of the mantle by early volcanism. Since then, the addition of new water has continued at a slow but steady rate, with the oceans possibly rising a few centimeters over a period of 1 million years.

See also: Earth, geological history of.

earth-moving machinery Earth-moving machinery is the heavy, mechanized equipment used to break up, shift, and remove soil in construction, mining, and engineering projects. The soil to be moved may range from soft clay, to solid rock that must first be broken down into removable pieces by blasting, to the sand removed in underwater excavation. The great advances in earth-moving machinery of the past few decades can be attributed primarily to the development of larger machines for use in open-pit and strip mining, where enormous masses of rock and soil must be moved.

The oldest type of excavating machine is the *power shovel*, essentially a toothed scoop or bucket attached to the end of a movable boom. Bucket shovels, powered by steam and mounted on railroad tracks, were used as early as the 1830s. Modern shovels are mounted on movable cabs, usually caterpillar-treaded. The most frequently used bucket, the *dipper shovel*, is a hinge-bottomed bucket mounted on a fairly short boom. Dippers are used on hard ground, where a long boom reach is not needed. On soft or waterlogged ground where a heavy machine might founder, the *dragline*—a bucket on the end of a long boom and controlled by wire cables—has a longer reach. The *backhoe*, is used primarily to excavate below the ground surface adjacent to the machine. It is used for digging trenches, basements, and pits, and, unlike other excavators, it pulls its load toward the machine. The *clamshell* is a bucket with two movable jaws controlled by cables. It is used for moving loose material such as sand, gravel, or coal; for removing loose earth from cofferdams and trenches; and for deep excavations, such as well-digging.

A *bulldozer* is a heavy, powerful tractor on which a broad steel blade is mounted. The blade can be lowered below the surface of the ground for excavating, for pushing quantities of earth and rock on the ground surface, and for grading.

Some excavating machines use a series of buckets

The heavy-duty scraper is used extensively in highway construction for excavating roadbeds. Essentially a towed, two-wheeled box, it is open in front and fitted with a blade that scrapes earth up into the box as the machine moves.

mounted in a circle on a large wheel or on an endless steel chain that moves along a boom or ladder. As the wheel or chain circles, the buckets are forced in turn into the material to be excavated, lift it out, and deposit it when they reach a point on the circle where they are upended. Huge *bucket wheels* are used in mining, where they excavate and move loose ores, and for excavating trenches for pipeline laying.

A *scraper* is an open-fronted box whose bottom edge can be sunk below ground surface to excavate a layer of earth as it moves. Scrapers are among the largest of the earth-moving machines, and some have capacities in excess of 38 cubic meters (50 cubic yards). *Graders* are used to shape ground surfaces, particularly where roads are to be built. Mounted under a tractor, the grader blade can be tilted in any direction to conform to the desired surface shape.

See also: DERRICK AND CRANE; DREDGING.

Earth sciences In its strictest sense, as used by geologists, the term *Earth science* is synonymous with GEOLOGY, the study of the solid part (LITHOSPHERE) of the planet Earth. More commonly, however, the Earth sciences are thought to include the study of the Earth's other major divisions, the ATMOSPHERE and HYDROSPHERE, as well as the planet's environment in space. Thus the term refers to broad, interrelated studies that encompass the SOLAR SYSTEM, atmospheric phenomena, and water, both on land (HYDROLOGIC SCIENCES) and in the sea (OCEANOGRAPHY), as well as the solid Earth. Mineralogy, the study of the origin and nature of the raw materials of the Earth, MINERALS, is closely related to PETROLOGY, the study of ROCKS of which these minerals are constitued. Geology also studies the processes associated with volcanic activity (see VOLCANO), dynamic earth movements (see PLATE TECTONICS), EROSION AND SEDIMENTATION, and WEATHERING. Other forces that shape the Earth are studied by meteorologists and oceanographers. In addition to examining the chemical composition and physical properties of the atmosphere and oceans, these scientists also examine the motions of air and water and their contributions to LANDFORM EVOLUTION.

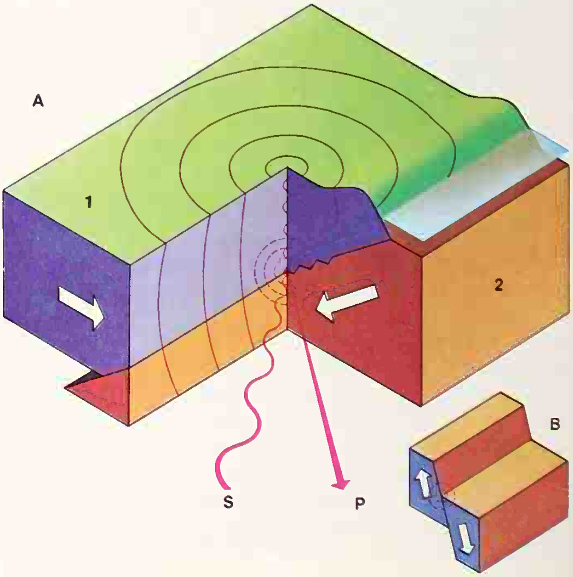
In recent years, the scope of the Earth sciences has been further expanded to include what are collectively known as the environmental sciences—studies directed mainly toward environmental conditions that affect living organisms in a general way (see ECOLOGY) and adversely (see POLLUTION, ENVIRONMENTAL).

Earth tide Earth tides, also known as body tides, are similar to TIDES in the ocean. Responding ever so slightly to the gravitational attraction of the Moon, the solid, almost perfectly rigid Earth bulges about 7 to 15 cm (3 to 6 in) twice a day. The Moon attracts the oceans, the atmosphere, and the solid Earth, creating a high tide on the side facing the Moon, where the gravitational attraction is greatest, as well as on the opposite side of the planet, where the attraction is least.

earthenware see POTTERY AND PORCELAIN

earthquakes An earthquake is a naturally induced shaking of the ground, caused by the fracture and sliding of rock within the Earth's crust. Of the 6,000 earthquakes detected throughout the world each year, 5,500 are either too small or too far from populated areas to be

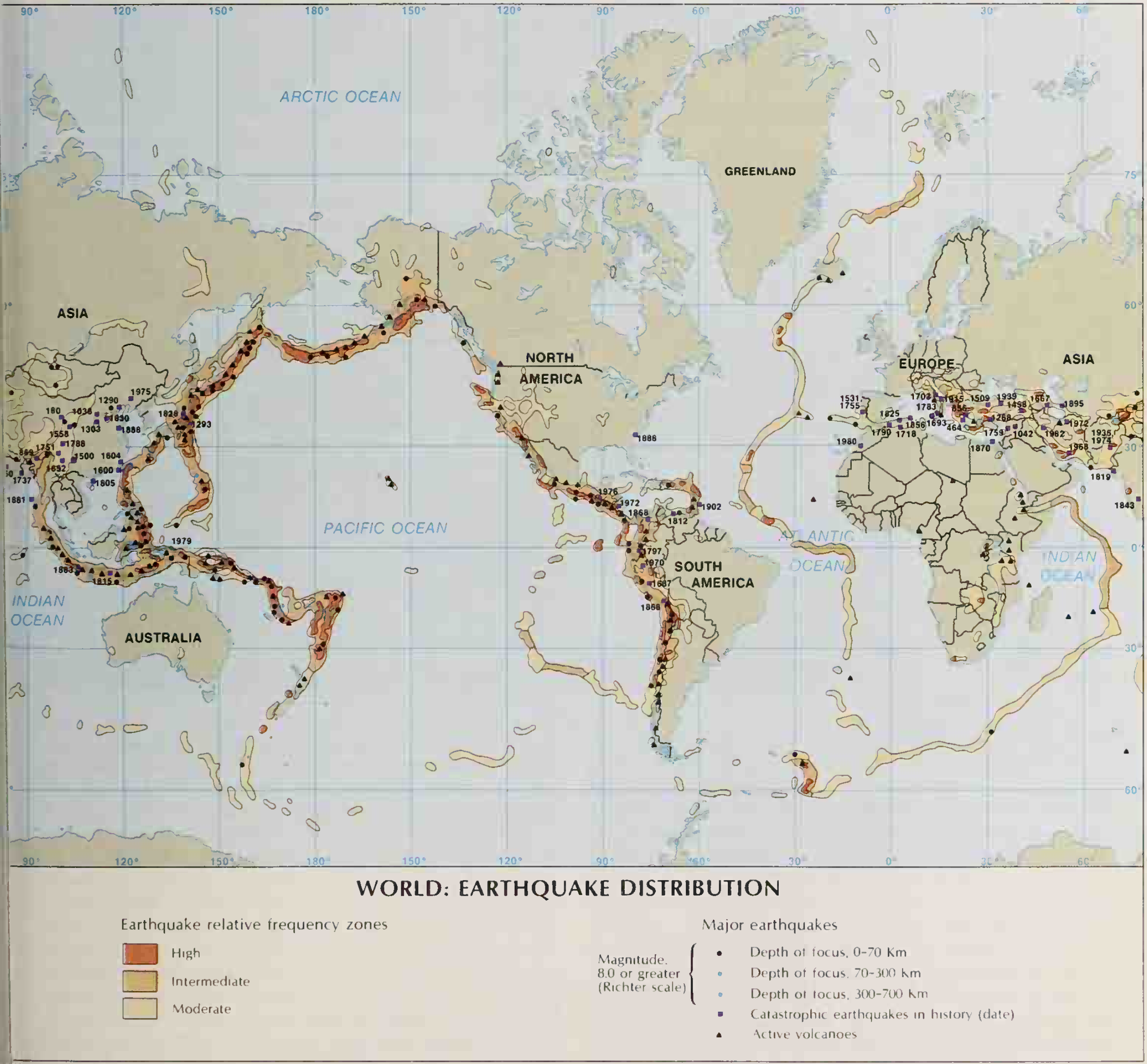
Major earthquakes result from the sudden movement (A) of one lithospheric plate (1) past another (2). When stresses exceed the breaking strength of rocks, slippage and violent shock waves occur. The place where vibrations originate is called the focus, and the surface point directly above the focus is termed the epicenter. Primary (P) and secondary (S) waves travel below the surface, and slower, long waves move along the surface. Minor earthquakes may be caused by local faults (B), in which rock strata slip over each other.

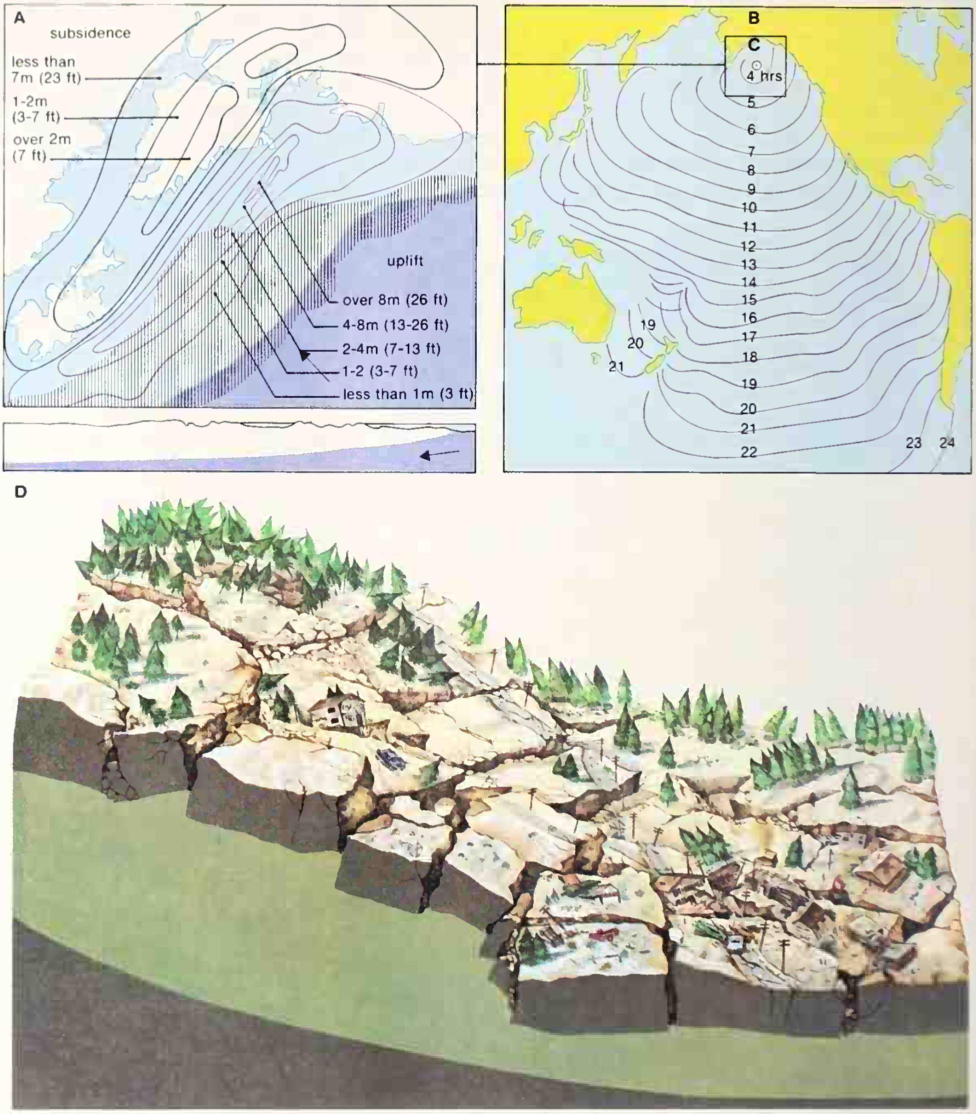


felt directly. Another 450 are felt but cause no damage, and 35 cause only minor damage. The remaining 15, however, can exact great tolls in death and suffering, besides heavily damaging bridges and buildings.

Size

The size of an earthquake is determined by the dimensions of the rupturing fracture, or FAULT, and by the total amount of slip, or displacement, that takes place on it. The larger the fault surface and slip, the greater the energy released during the earthquake. In addition to deforming the rock near the fault, this energy produces the shaking that occurs at the time of the earthquake and a variety of seismic waves that radiate throughout the Earth. While small earthquakes involve a few centimeters of slip on faults only tens or hundreds of meters long, a great earthquake may involve


A world map showing the distribution, relative frequency, and dates of major earthquakes reveals that most large earthquakes occur in two great belts. The majority of shocks originate in the circum-Pacific belt around the edges of the Pacific Ocean. Most of the remaining shocks take place in the Mediterranean zone, which runs eastward from the Azores across Europe and Asia.



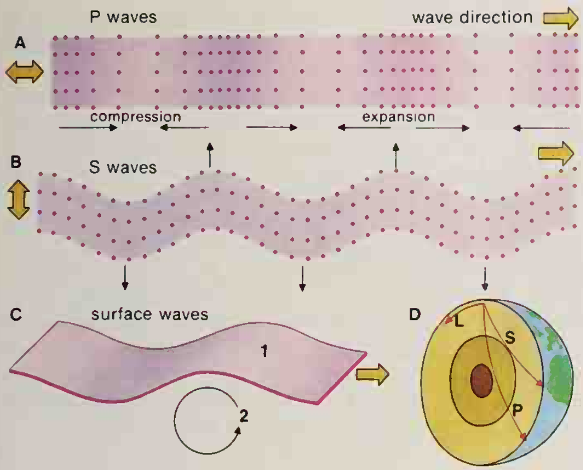
On March 27, 1964, one of the strongest earthquakes of the 20th century occurred under Prince William Sound in Alaska, with an epicenter located about 120 km (75 mi) southeast of Anchorage. The shock, which originated where the Pacific Plate is thrusting beneath the Alaskan landmass, had a magnitude of about 8.5 on the Richter scale, approaching the maximum known. Extensive changes in elevation were caused around the Gulf of Alaska (A), *some sections subsiding over 2 m (7 ft) and others rising over 8 m (26 ft). In some coastal areas* (B) *large blocks of alluvial deposits were loosened by the vibrations and slid down steep slopes. Devastating ocean waves, or tsunamis, generated by these slides and by 15-m (50-ft) movements of the sea floor during the earthquake, caused great damage as far away as California. Successive hourly positions of the tsunamis* (C) *reveal that the waves reached the tip of South America in 24 hours. At Anchorage* (D) *most of the damage was caused by the fluid movements of weak clays underlying the city, which caused the ground to break up into chaotic piles of slabs.*

meters of slip on a fault hundreds of kilometers long.

Shaking at the site of the earthquake lasts only during the time when the fault ruptures, a process that takes seconds or at most a few minutes. The seismic waves generated by the rupture continue to propagate after the movement on the fault has stopped, spanning the globe in 20 minutes. Only in the immediate vicinity of the fault, at the earthquake's epicenter, are these vibrations powerful enough to cause damage.

Seismic waves can be detected at great distances from the epicenter of an earthquake and are therefore very useful in earthquake studies. SEISMOMETERS, the instruments that record these waves, can monitor earthquake activity over large portions of the globe, including regions where on-site measurements can seldom be made (ocean basins, for example). The record of P- and S-wave (pressure and shear) arrivals contained in the SEISMOGRAM can be used to determine the epicenter and the size and orientation of the fault (see GEOPHYSICS).

Seismologists use several methods to categorize the size of earthquakes. One method, that of ranking an earthquake according to its seismic intensity, emphasizes its effect upon people by ranking, on an ordinal scale, the amount of damage to buildings and other structures. The Modified Mercalli Scale is the most commonly used scale of this type. It ranks earthquakes from intensity I (barely felt) to intensity XII (total destruction). Since the destruction caused by earthquakes depends upon building practices, soil conditions, and population density near the epicenter, as well as the total amount of energy



Earthquakes generate three wave types: P, or primary, waves (A)*; S, or secondary, waves* (B)*; and surface waves* (C)*. Particles of matter through which P waves travel move back and forth in the direction of wave motion like a coiled spring. S waves cause particles to oscillate at right angles to the wave motion like a vibrating string. When P and S waves reach the surface they are converted into L, or Love, waves* (1) *that vibrate horizontally and Rayleigh waves* (2) *that move in elliptical orbits. The three major wave types follow very different paths* (D).

released by the earthquake, intensity measurements are not generally used in the study of the earthquake process itself. Other scales based on more carefully controlled measurements are used; the best known is the RICHTER SCALE (1935), which is based on the amplitude of the seismic waves radiated by the earthquake. Destructive earthquakes of Mercalli intensity IX or X generally register more than 6.5 on the Richter scale.

Dynamics

Earthquakes are commonplace rather than extraordinary events, reflecting the slow but continual motion of material within the Earth. Almost all occur near the Earth's surface, in the 100-km (60-mi) thick, relatively brittle shell called the LITHOSPHERE. The lithosphere is broken up into 12 to 15 rigid plates that move independently, continually colliding and sliding past one another. Earthquakes occur with greatest frequency at the boundaries of these plates (see PLATE TECTONICS). These zones or belts of intense seismicity are separated by the central portions of the plates—ocean basins and CONTINENTAL SHIELDS—which are relatively inactive. One plate boundary, the one that borders the Pacific plate, is the source of nearly half of the world's great earthquakes and many of its VOLCANOES. Stretching 40,000 km (24,000 mi), this Pacific RING OF FIRE includes such highly populated areas as Japan and the west coast of North America.

While the heat and great pressure of the Earth's interior allow material there to flow smoothly and plastically, the motion of the lithospheric plates occurs in sporadic jumps. Great stresses that accumulate within the plates over a period of years are suddenly released when they exceed the breaking strength of the rock.

TABLE 1: GREAT EARTHQUAKES OF THE 20TH CENTURY

Date	*Location*	*Fatalities*	*Richter Magnitude*
Apr. 4, 1905	Kangra, India	375,000	8.3
Apr. 18, 1906	San Francisco, Calif.	700	8.3
Dec. 28, 1908	Messina, Italy (Sicily)	160,000	7.5
Dec. 16, 1920	Gansu, China	100,000	8.6
Sept. 1, 1923	Sagami Bay, Japan	200,000	8.3
Dec. 26, 1939	Erzincan, Turkey	30,000	6.0
Aug. 15, 1950	Assam, India	30,000	8.4
Feb. 29, 1960	Agadir, Morocco	15,000	5.9
May 22, 1960	Arauco, Chile	2,000	8.4
Sept. 1, 1962	Iran	12,000	7.3
Mar. 27, 1964	Anchorage, Alaska	114	8.5
Dec. 23, 1972	Managua, Nicaragua	10,000	6.2
Feb. 4, 1976	Guatemala City, Guatemala	23,000	7.5
July 28, 1976	Tangshan, China	695,000	7.9
Sept. 16, 1978	Northeastern Iran	25,000	7.7
Oct. 10, 1980	Algeria	20,000	7.5
Nov. 23, 1980	Southern Italy	3,000	6.8
Sept. 19, 1985	Mexico City	7,000	8.1
Mar. 5, 1987	Ecuador	4,000	7.3
Dec. 7, 1988	Armenian SSR	25,000–45,000	6.9
Oct. 17, 1989	Northern California	67	7.1

TABLE 2: GREAT EARTHQUAKES OF HISTORY

Date	*Location*	*Remarks*
AD 365	Eastern Mediterranean area	Tsunami after quake leveled the Pharos of Alexandria
526	Antioch, Syria (now Turkey)	250,000 deaths; Antioch destroyed
1556	Northern China	830,000 deaths
1692	Jamaica	Seismic waves destroyed city of Port Royal
1703	Tokyo	200,000 deaths
1755	Lisbon	60,000 deaths on All Saints' Day; greatly influenced 18th-century European thought
1783	Calabria, Italy	181 villages leveled; 30,000 deaths
1812	Venezuela	Destroyed city of Caracas
1868	Peru	Tsunami reached points 4.5 km (3 mi) inland
1896	Honshu, Sanriku Coast, Japan	27,000 killed by tsunami

The relative velocity between adjoining plates is greatest where one plate is colliding with another. The thrust faults that develop at these collision sites tend to dip at very low angles through a relatively thick lithosphere, forming a fault plane with a particularly large surface area. The combination of high relative velocity and large fault plane results in particularly large earthquakes.

Relative plate velocities are also high at transform plate boundaries, where adjoining plates slide past one another. The TRANSFORM FAULTS, such as the SAN ANDREAS FAULT, that form at these boundaries are vertical, passing through the lithosphere in a short distance. Although major earthquakes occur here, they generally do not exceed 7.5 on the Richter scale.

Effects and Prediction

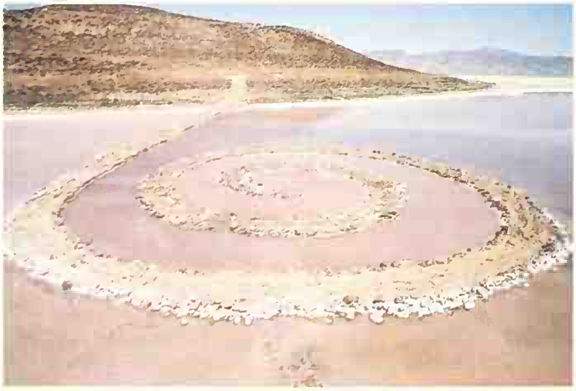
Earthquakes are among the deadliest of natural catastrophes. The average death toll in the 20th century has been 20,000 people annually. Most deaths are caused by the collapse of houses, bridges, and other structures. Although buildings located along a fault may be torn apart, more damage is caused by the shaking alone, which can topple structures far from the fault. The force of this shaking has been known to approach the acceleration of gravity.

Earthquakes also cause indirect damage through landslides, fires, and the collapse of dams. The civil disorder that follows can lead to the disruption of food and water supplies and sanitation systems, causing starvation and the spread of disease. Earthquakes that occur under or near the ocean can also generate tidal waves, more properly called tsunamis, or seismic sea waves. Reaching heights of up to 15 m (50 ft), these waves can cross an ocean in several hours, inflicting damage on shores far from the earthquake itself.

The accumulation of stress and the weakening of rock that precede an earthquake have measurable consequences, which, if detected soon enough, can signal an alert. Sudden lowering of groundwater levels, tilts and bulges in the Earth's surface, changes in the velocity of propagation of P- and S-waves, increased concentrations of rare gases in well water, changes in the Earth's magnetic field, and geoelectric phenomena have been observed prior to some, but not all, earthquakes. The observation of these precursory phenomena has led to the birth of a new science—earthquake prediction.

earthworks In archaeology the term *earthwork* refers to a prehistoric ditched enclosure usually used as a fortification, but the term is applied to diverse art forms produced by American and European artists beginning in the late 1960s, in which the finished work becomes an integral part of the environment where it is created. Representing a revolt against the concept of ownership of art, earthworks are generally produced in the form of immense outdoor sculptures, erected by means of engineering procedures and manual labor. Most are situated in remote areas and are integrated with the landscape either by moving or intersecting natural elements of the site (geological or architectural), by displacing masses of the terrain, or by creating illusive spaces within the chosen locale. The term was first used in 1967 by Robert Smithson, major maker and theorizer of earthworks. Smithson's major work is *Spiral Jetty* (1970), a towering formation of salt crystal and rock built on the north shore of the Great Salt Lake, in Utah. Other prominent earthwork artists include Walter De Maria and Michael Heizer.

The American artist Robert Smithson's Spiral Jetty *(1970) is an example of an earthwork, using the natural environment as a sculptural space.*



earthworm Earthworms are various terrestrial annelids, segmented worms belonging to the class Oligochaeta. Earthworms play a significant role in improving the soil. Their burrowing allows more air and water to reach deeper into the ground. They also aid the soil by feeding on decaying organic matter, generally by swallowing the soil containing it and then depositing the bulk of the soil as wastes, called castings, on the ground; the castings contain partially digested material that enriches the soil. Earthworms are important food for many animals. They are raised for fish bait and for soil improvement.

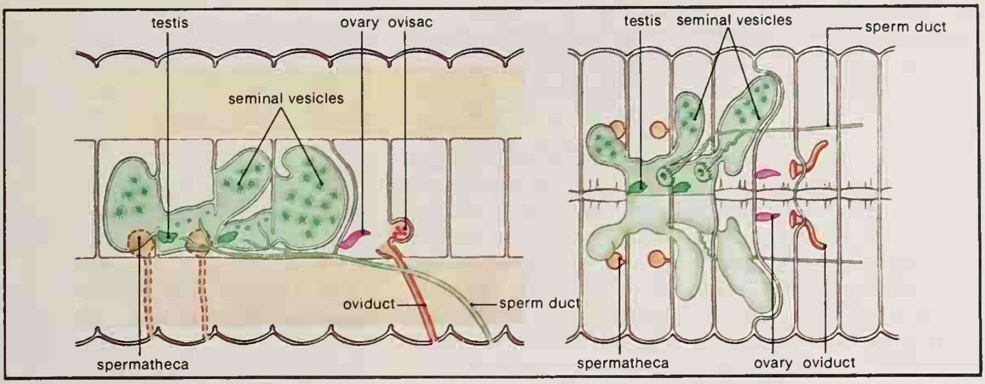
The common earthworm, *Lumbricus terrestris*, grows to about 25 cm (10 in) long and 1 cm (0.4 in) in diameter. The largest is the giant Australian earthworm, *Megascolides australis*, which reaches a length of more than 3 m (10 ft) and a diameter of 2.5 cm (1 in). Earthworms are commonly reddish; the British *Allolobophora chlorotica*, however, is green.

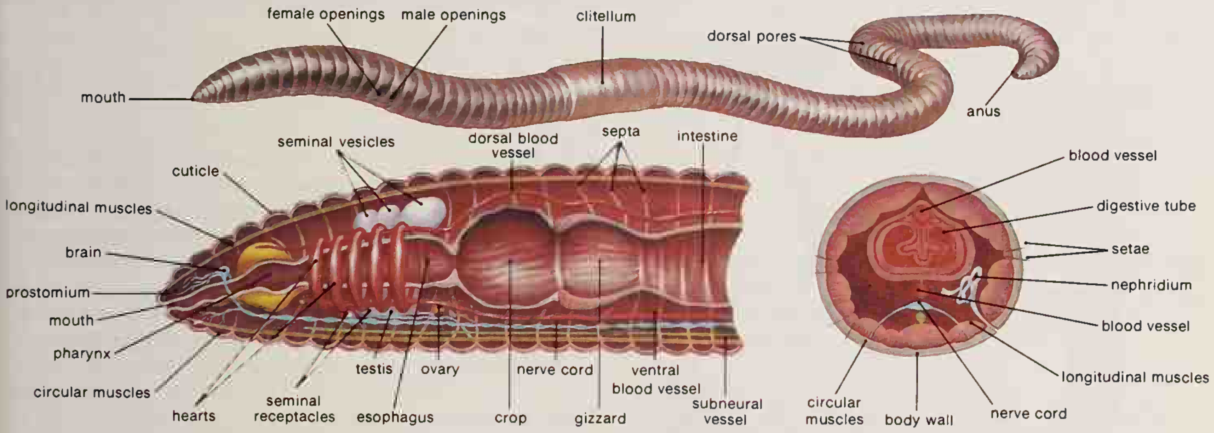
The body wall of the common earthworm is composed of an outer layer of circular muscles, which decrease the diameter of the body, and an inner layer of longitudinal muscles, which shorten the body. The muscle systems are overlain by a skin of epidermal tissue and a cuticle. The worm's entire body is divided into about 150 similar segments, each separated by an internal partition. Each segment except the first and last bears four pairs of stiff bristles, or setae, which are extended, tilted, or retracted by special muscles. The worm moves forward by stretching the front part of its body, anchoring it by extending the setae out and toward the rear, and then drawing up the rearward portion of its body.

The digestive tract is a relatively straight tube. Food is taken into the mouth and swallowed by the pharynx. It passes through the narrow esophagus and enlarged storage-area crop into the gizzard, where, with the help of mineral particles, it is ground. Next, the food enters the intestine, where it is digested and absorbed; remains are ejected from the anus.

The circulatory system has an upper (dorsal) vessel, two lower (ventral) vessels, and connecting vessels between these in each segment. Near the esophagus the

Drawings show external features (A) *of the earthworm, as well as organs of the circulatory, digestive, nervous, muscular, and excretory systems* (side view, B, and cross section, C). *Each reproductive system* (views from side, D, and above, E) *includes both male and female organs. After worms exchange spermatozoa, fertilization occurs in the cocoon secreted by each clitellum.*





connecting vessels are five pairs of enlarged, muscular tubes, called hearts. These pump blood from the dorsal vessel to the ventral vessels, which carry the blood to the various segments. The connecting vessels carry the blood from the tissues back to the dorsal vessel, which moves the blood to the hearts. The blood contains a reddish hemoglobinlike respiratory pigment, which gives the worm its usual coloration. Earthworms lack lungs and gills; respiration occurs through the moist skin surface. This also enables earthworms to respire in water. The death of worms flooded from burrows by oxygen-poor water is generally caused by exposure to sunlight.

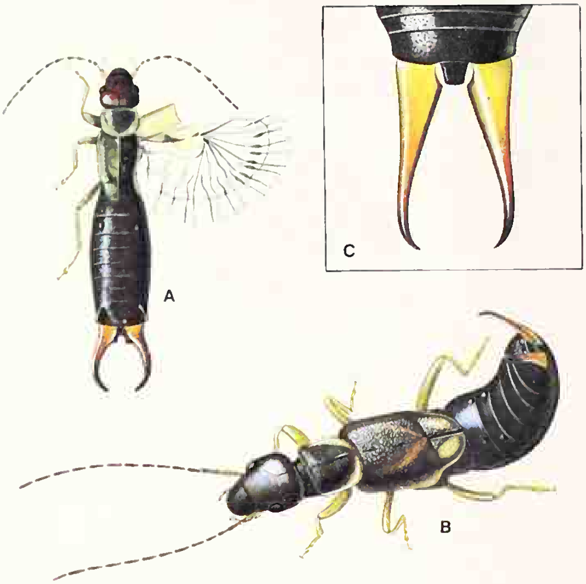
The nervous system has a large ganglion (a "brain") above the pharynx that is connected by two nerves to another large ganglion lying below the pharynx. A nerve cord runs from the lower ganglion to the rear of the body, enlarging in each segment to form a small ganglion, which sends out branches.

The worm's excretory system consists of a pair of coiled tubes, or nephridia (kidneys), in each segment except the first three and the last. The nephridia withdraw dissolved waste from the fluid-filled central body cavity and pass it outside.

An earthworm is hermaphroditic, with both male and female organs. It also has two pairs of sperm receptacles. Behind the sex organs is a swollen area, the clitellum. During mating, both worms secrete mucus, covering each other with a "slime tube" from segment 9 to the rear of the clitellum. Sperm are released and carried in grooves, now formed into tubes by the adjoining slime-covered worm, to the sperm receptacles of the partner. The worms then separate. Later the clitellum secretes a mucous ring, which slides forward over the worm's body, gathering several eggs from the oviducts and sperm from the receptacles. Fertilization takes place within the mucous ring, which slips off the front of the worm, closing at both ends to form a capsule. One or two worms later hatch from this capsule, or cocoon. Worms that have been mated may form new egg capsules every few days.

earwax Earwax, or cerumen, is secreted by special glands in the wall of the outer EAR canal. The glands are essentially modified sweat glands. The wax they secrete, together with hair follicles in the canal, helps to protect against foreign matter entering the ear. Usually the wax works its way out of the canal on its own. In some persons, however, it tends to build up and harden. If not removed, it can then cause some hearing loss. A person should not attempt to remove such wax balls, because damage to the eardrum or the ear canal may result, but they are easily removed by a doctor.

earwig Earwigs are small to medium-sized, usually brownish insects that have a pair of pincers at the end of the abdomen. The approximately 900 species, constituting the order Dermaptera, are distributed worldwide. Most resemble the common earwig, *Forficula auricularia*. Some species are wingless, however, and two tropical genera are parasites on bats and rodents. The name "earwig" derives from tales about the insects crawling into ears. Earwigs feed on both plants and small animals, sometimes capturing prey by using the pincers, which are strong enough to nip human skin. Female earwigs display primitive social behavior by tending their eggs and young, which resemble the adults and undergo simple metamorphosis. The insects are mainly nocturnal and can be a pest in gardens by damaging flowering plants.



A male earwig (A) *differs from a female* (B) *by having wings, one pair of which is short and leathery and the other pair veined and delicate. Both male and female have forcepslike pincers on their abdomens* (C), *which are used for defense. The female is shown in a defensive posture, with pincers raised.*

easement An easement is a right of the owner of a parcel of land to use land belonging to a neighbor for a special purpose. For instance, it gives the right to cross another person's land to reach a main highway or to take water from a stream running through both properties.

Although an easement may arise through custom, it is usually created by express agreement with a property owner. If a person has used a neighbor's road or driveway for a long period of time, a court may rule that an implied easement exists.

East Africa East Africa is a region on the African continent that includes the countries of Somalia, Kenya, Tanzania, Uganda, Burundi, and Rwanda. Bounded on the east by the Indian Ocean, the region consists largely of a plateau dotted by high peaks. The plateau is traversed by the East African Rift System. Although culturally diverse, the indigenous African inhabitants speak the lingua franca of Swahili. Sizable minorities of Europeans, Arabs, and Indians also live in the region.

East African Rift System see rift valleys

East Anglia East Anglia, one of the Anglo-Saxon kingdoms of England, borders on the North Sea and includes the modern counties of Norfolk and Suffolk. Low, forested hills separate The Fens (now drained and cultivated) in the west from the shallow river valleys with flooded peat hollows ("Broads") and estuaries in the east.

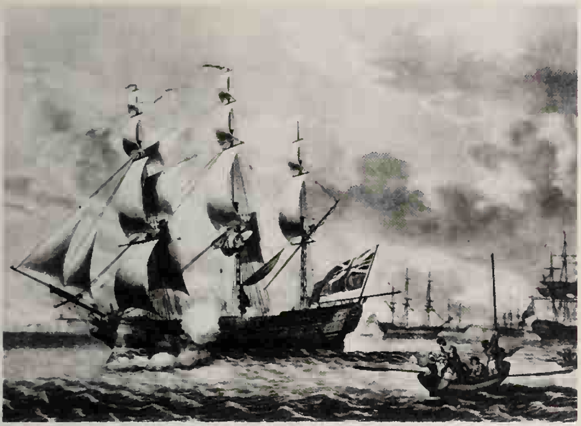
East Anglia was settled in the 5th century by Saxons, Angles, Swabians, and Frisians. Little is known of early East Anglian kings prior to Raedwald (r. *c*.600–*c*.627). Raedwald was converted to Christianity, and his son founded (*c*.630) a see at Dunwich for the Burgundian bishop Felix. Rivalry with Mercia led to the subjugation of East Anglia by the mid-7th century. Danish invasions from the mid-9th century resulted in the inclusion (886) of East Anglia under Danelaw. In 917 the Danes were defeated by Edward the Elder, and East Anglia became an earldom of England.

East Germany see Germany

East India Company, British The British East India Company was chartered by Queen Elizabeth I in 1600 for trade in the Eastern Hemisphere. It was initially formed to break into the Indonesian spice trade, but soon the company concentrated on the Indian subcontinent, where it had established a base at Surat in 1612.

After founding a post at Madras in 1640, the East India Company was rechartered in 1657 and later given the right to coin money and exercise jurisdiction over British subjects in its posts and to make peace and war with non-Christian powers. In 1668 the company was given Bombay by Charles II, who had received it as a dowry when he married the Portuguese Catherine of Bragança. Calcutta was founded as the company's major center in Bengal in 1690. The substantial profit made from its trade in Indian cotton goods, silks, spices, and saltpeter enabled the company to pay an annual average dividend of 25 percent from 1660 to 1700.

After consolidating (1750–51) the company's position in Madras, Robert Clive reduced Bengal to a client state in 1757. Granted the right to collect revenue in Bengal and Bihar by the Mogul emperor, the company and its servants plundered Bengal in the 1760s. As governor-general (1774–85), Warren Hastings tidied up the ad-



The East Indiaman was a type of merchant vessel used by both the British and the Dutch East India companies in the trade with India and the East Indies from the 17th to the early 19th century.

ministration and extended company power into additional Indian states. The growing power of the company in both India and England then provoked parliamentary inquiries and greater government control. The Regulating Act of 1773 placed Bombay and Madras under the governor-general in Calcutta, and the India Act of 1784 set up a government Board of Control to oversee the company. Lord CORNWALLIS, governor-general from 1786 to 1793, began to transform the company from a commercial to an administrative agency and made numerous basic reforms.

In the 19th century the company's profit came increasingly from the China trade. Subject to renewal of its charter every 20 years, the company suffered gradual reduction of its privileges. Its trade monopoly was virtually abolished in 1833, by which time it had become simply an administrative agency. Its last great power, patronage, was ended in 1853 with the introduction of civil service examinations. In 1858, after the INDIAN MUTINY, the company was abolished, and India came under the direct rule of the British crown.

See also: INDIA, HISTORY OF.

East India Company, Dutch The Dutch East India Company established and maintained the Dutch colonial empire in Southeast Asia in the 17th and 18th centuries. It was originally a trading company, receiving its charter in 1602 from the States-General. Shares to a value of 6.5 million guilders were issued, which paid enormous dividends during the 17th century but declined in value during the following century.

Although intended primarily to conduct trade, the company conquered territories and acted as a sovereign state. From headquarters established at Batavia (Jakarta) on Java in 1619, it displaced the Portuguese from most of their Asian holdings and then fought off English attempts to break into the SPICE TRADE. It also won (1641) a monopoly on trade with Japan through the island of Dejima, off Nagasaki, after the Japanese had expelled the Portuguese. Increasing corruption and near bankruptcy led to the dissolution of the company in 1799.

East India Company, French Henry IV of France granted a charter to an East India Company in 1604, but that enterprise faded from sight. In 1664, Jean Baptiste COLBERT, the finance minister to Louis XIV, provided the stimulus for the creation of a new French East India Company, with a monopoly on trade spanning from the Cape of Good Hope east to the Strait of Magellan. The company's privileges included the right to export gold and silver, exemption from many import-export taxes, the right to hold slaves, and political jurisdiction over all lands seized.

Although the company established bases on the Indian Ocean islands of Réunion and Mauritius and in India, its grandiose schemes were never realized. It was incorporated (1719) in John LAW's Company of the Indies and shared in the financial collapse of the MISSISSIPPI SCHEME in 1720. Re-formed thereafter, it enjoyed some revival. Joseph François DUPLEIX, governor of Pondicherry, infused life into the company by his efforts to establish rule over southern India, but he was soon defeated by the British East India Company under Robert CLIVE.

Bankruptcy brought the dissolution of the French East India Company in 1769. Although refounded in 1785, the company was eclipsed in the 19th century.

See also: FRENCH COLONIAL EMPIRE.

East Indies The name *East Indies* usually refers to Indonesia (the former Dutch East Indies), but it is sometimes applied to all Southeast Asia and even India.

East London East London (Afrikaans: Oos-Londen) is a city at the mouth of the Buffalo River, Cape Province, South Africa. It has a population of 84,729 (1985). Established by the British as a supply base during the Kaffir War of 1847, it has become an important industrial town and port, handling pineapples, grain, and wool from the eastern Cape and from Transkei.

East Pakistan see BANGLADESH

Easter The Christian festival of Easter celebrates the RESURRECTION of JESUS CHRIST. The spring festival has its roots in the Jewish PASSOVER, which commemorates Israel's deliverance from the bondage of Egypt, and in the Christian reinterpretation of its meaning after the crucifixion of Jesus during the Passover of AD *c.*30 and the proclamation of his resurrection three days later. Originally, the Christian Easter was a unitive celebration, but in the 4th century GOOD FRIDAY became a separate commemoration of the death of Christ, and Easter was thereafter devoted exclusively to the resurrection.

The name *Easter* is derived from the pagan spring festival of the Anglo-Saxon goddess Eostre, and many folk customs associated with Easter (for example, Easter eggs) are of pagan origin. Easter Day is currently determined as the first Sunday after the full moon on or after March 21. The Eastern Orthodox churches, however, follow the Julian rather than the Gregorian calendar, so their celebration usually falls several weeks later than the Western Easter.

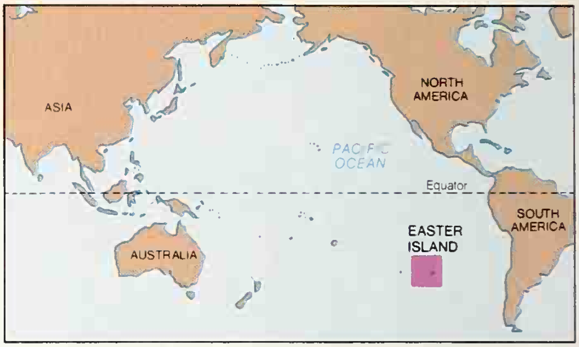
Easter Island Easter Island (Spanish: Isla de Pascua) is a Chilean dependency situated in the southeastern Pacific Ocean, about 3,700 km (2,300 mi) west of Chile. Famous for its giant stone statues, the triangle-shaped island has an area of 117 km^2 (45 mi^2). Its Dutch discoverers called it Paaseiland (Easter Island) to commemorate the day it was sighted.

Easter Island consists of three extinct volcanoes (the highest reaches 538 m/1,765 ft) and craters, separated by low plains. Although no rivers or streams cross the landscape, the sparse soil supports enough vegetation to graze sheep. The climate is subtropical.

The population of 2,000 (1986 est.) is divided between peoples of South American and Polynesian origin and is concentrated in Hanga Roa, a town on the west coast. Intermarriage is common. Sheep raising is the major activity, although tourism is increasingly important.

Easter Island's original population is thought to have arrived from Polynesia in the early centuries AD. They used stone tools to carve huge statues of humans, apparently in quarries within the volcano of Rano Raruku. These figures, which number about 600, are mostly between 3 and 6 m (10 and 20 ft) high; the largest is 11 m (37 ft) high. Some weigh up to 45 metric tons (50 U.S. tons). During a time of internal conflict, it is thought, all of the statues were toppled from their bases. Examples of an ancient script exist but have not been deciphered.

Moai, *monolithic statues carved by the early inhabitants of Easter Island, overlook a hillside. Archaeologists have found more than 600* moai, *whose origin is obscure.*



The map indicates the position of Easter Island, a volcanic island in the South Pacific named for the day of its discovery in 1722.

Two major archaeological expeditions, led by Alfred Métreaux (1934–35) and Thor Heyerdahl (1955), reached differing conclusions on the early history of the island. A recent study suggests that deforestation probably caused the collapse of the social order there.

In 1722, Jacob Roggeveen, a Dutch admiral, became the first European to visit Easter Island. James Cook, the British explorer, landed there in 1744. In the 19th century the island's population was nearly eradicated by slave raids and epidemics. Chile annexed Easter Island in 1888.

Easter Rising The Easter Rising, an Irish insurrection against British rule, took place in Dublin in April 1916. It was led by members of the Irish Republican Brotherhood (earlier known as Fenians). Most of the participants were members of the Irish Volunteers, a paramilitary force formed during the crisis over the Home Rule Bill of 1912 and sustained by disappointment over the postponement of home rule for the duration of World War I. The rising was unpopular and was suppressed within a

The city of Dublin was virtually paralyzed, and its main commercial district virtually destroyed, during the Easter Rising of 1916, a week-long rebellion led by Irish republican groups.

week, although subsequent executions of 15 of its leaders, including the writer Patrick Pearse, evoked widespread sympathy, which worked to the political benefit of the Irish nationalist movement Sinn Fein.

See also: Ireland, history of.

Eastern Europe The term *Eastern Europe* usually refers to the region of Europe extending from the western borders of Poland, Czechoslovakia, Hungary, and Yugoslavia eastward across the USSR to the Ural Mountain range. Because it was often used to designate the Communist countries of Europe other than the USSR, the term also included the former East Germany.

Eastern Orthodox church see Orthodox church

Eastern Question The Eastern Question refers to the diplomatic problems associated with the decline of the Ottoman Empire during the 19th century. The European powers recognized two major courses of action as feasible: they could agree on maintaining a weak Ottoman Empire, or they could conspire together to partition it. It was feared that the latter solution would alter the European balance of power and threaten peace. Another complicating condition was the emergence of nationalism among the subject peoples of European Turkey. The Serbs, Greeks, Romanians, and Bulgarians struggled against their Turkish rulers to establish their own nation-states—not always with the approval of all the European powers.

The Ottoman Empire skillfully exploited international rivalries. While Austria and Russia, in particular, sought to expand southward into the Balkans at the expense of the weak Turks, Britain generally sought to counter these advances by supporting the Ottoman government in its diplomatic and, on occasion, its military struggles. The British wanted especially to prevent Russia from acquiring control of Constantinople and the strategic Straits, which would have threatened Britain's lucrative trade ties with Turkey, its Mediterranean naval power, and its dominant position in India.

The major powers of Euopre (left to right: Russia, Britain, Germany, France, and Austria) try to keep a lid on the boiling cauldron of "Balkan Troubles" in this editorial cartoon of the late 19th century. The dissolution of the Ottoman Empire aroused imperialist designs among rival powers and stirred nationalist sentiments in the Balkans.

The Greek War of Independence (1821–29), the crises provoked by Muhammad Ali's wars with the Turks (1831–33 and 1839–41), the Crimean War (1853–56), and the Russo-Turkish Wars of 1877–78 were conflicts associated with the Eastern Question. It receded into the diplomatic background after the dissolution of the Ottoman Empire at the end of World War I.

Eastern Rite churches Eastern Rite churches are communities of eastern Christians in union with the Roman Catholic church. Also known as Uniate churches, they retain their own distinctive spiritual, liturgical, and canonical traditions. In addition to differences from the Roman (Western) rite in liturgy, many of the Eastern Rite churches permit a married clergy.

Like the Orthodox church, these churches are divided into families; the five major families are the Alexandrian, Antiochene, Armenian, Chaldean, and Byzantine. They often originated among Orthodox and other eastern Christian communities under the political influence of a Roman Catholic sovereign. The largest Eastern Rite church—the Ukrainian Catholic church—was formed when Ukrainian subjects of the king of Poland were united with Rome in 1596. Another large group—the Maronites of Lebanon—established ties with the papacy when their country was occupied by Western Crusaders in the 12th century. The Romanian Eastern Rite church was created under Habsburg rule in 1700.

The Ukrainian Catholic church is concentrated in the western Ukraine, especially in the areas of Lvov and Ivano-Frankovsk, which were under Austrian and Polish jurisdiction until World War II. After the war, when the region became part of the USSR, the church was outlawed and driven underground by the Soviet government. It was allowed to resume open activity in the freer atmosphere of the late 1980s.

Each of the Eastern Rite churches is headed by its own patriarch, who has jurisdiction over the bishops, clergy, and people of that rite. All of the patriarchs are members of the Congregation for the Oriental Churches, which governs the relations of the Vatican with the Eastern Rites.

EASTERN RITE CHURCHES AND THEIR CONSTITUENT ETHNIC GROUPS

Alexandrian
Coptic
Ethiopian

Antiochene
Malankar
Maronite
Syrian

Byzantine
Albanian
Bulgarian
Georgian
Greek
Hungarian
Italo-Albanian
Melchite
Romanian
Russian
Ruthenian
Slovak
Ukrainian
White Russian
Yugoslavian

Chaldean
Chaldean
Malabar

Armenian

Eastman, George George Eastman, b. Waterville, N.Y., July 12, 1854, d. Mar. 14, 1932, founded (1892) the Eastman Kodak Company. While working as a bank clerk, he became interested in PHOTOGRAPHY. He refined the process for making photographic plates, which he soon began to manufacture, and in 1884 he introduced flexible film. He produced his Kodak box CAMERA in 1888, marketing it on a mass basis for amateur photographers. Large investments in research led to further innovations in cameras and equipment, including daylight-loading film and pocket cameras. Eastman gave enormous sums to educational institutions, and in his company introduced the first employee profit-sharing system in the United States.

Eastman, Max Max Forrester Eastman, b. Canandaigua, N.Y., Jan. 4, 1883, d. Mar. 25, 1969, was a leading socialist literary figure during the first quarter of the 20th century, though he is perhaps best remembered for the critical stance he later took toward the USSR and the nature of Marxism in such books as *Marxism: Is It a Science?* (1940) and *Reflections on the Failure of Socialism* (1955). Earlier in his career he edited two socialist publications, *The Masses* (1912–17), which was suppressed by the federal government for its antiwar sentiments, and *The Liberator* (1918–21); both journals sought to combine politics and art. Also a translator (of Trotsky's works) and poet, Eastman wrote extensively about literature, and his *Enjoyment of Poetry* (1913) became a standard college text. His views are treated more extensively in two autobiographical volumes: *Enjoyment of Living* (1948) and *Love and Revolution: My Journey through an Epoch* (1965).

Eastman School of Music The Eastman School of Music, founded in 1919, was given by George Eastman to the University of Rochester, New York. It is one of the foremost U.S. music conservatories, offering degrees in composition, music education, music history, music theory, and music performance. The school has had three directors: Howard Hanson (1924–64), Walter Hendl (1964–72), and Robert Freeman (from 1973). Under Hanson the school established an opera department, motion picture and radio broadcasting departments, two chamber orchestras, and two symphony orchestras—the Eastman Philharmonic and the Eastman School Symphony.

Eastwood, Clint The American film actor and director Clint Eastwood, b. San Francisco, May 31, 1930, after his stint in the Western television series "Rawhide," achieved international stardom in three "spaghetti" Westerns directed by Sergio Leone—*A Fistful of Dollars* (1964), *For a Few Dollars More* (1965), and *The Good the Bad and the Ugly* (1966). Eastwood's laconic, antihero persona of these films, the Man with No Name, continued to surface in other Westerns he made, such as *High Plains Drifter* (1973) and *Pale Rider* (1985), and also emerged in the title role of *Dirty Harry* (1971) and its sequels, set in modern-day San Francisco. He has directed several films, including *Play Misty for Me* (1971), *Bird* (1988), and *White Hunter, Black Heart* (1990). In 1986, Eastwood was elected mayor of Carmel, Calif.

Eaton, John Henry John Henry Eaton, b. Halifax, N.C., June 18, 1790, d. Nov. 17, 1856, was a U.S. senator from Tennessee (1818–29) who helped promote Andrew JACKSON's election to the presidency in 1828 and then became (1829) Jackson's secretary of war. Eaton's marriage to Margaret O'Neale, a woman considered socially unacceptable by Washington society, caused friction in the cabinet and eventually led to his resignation in 1831 and to reorganization of the cabinet. Thereafter, Eaton was governor of the Territory of Florida (1834–36) and ambassador to Spain (1836–40).

Eban, Abba [ee'-buhn, ahb'-uh] Abba Solomon Eban, b. Capetown, South Africa, Feb. 2, 1915, is an Israeli diplomat and political leader. From 1949 to 1959 he served as Israel's first permanent representative at the United Nations and from 1950 to 1959 as ambassador to the United States. Eban sat (1959–88) in the Knesset as a member of Mapai, Israel's Labor party. He was minister of education and culture (1960–63), deputy prime minister (1963–66), and foreign minister (1966–74). His books include *My People* (1968), *My Country* (1972), *Abba Eban: An Autobiography* (1977), and *Heritage* (1985).

Ebbinghaus, Hermann [eb'-ing-hows] Hermann Ebbinghaus, b. Jan. 24, 1850, d. Feb. 26, 1909, was the first person to show that higher mental processes could be studied experimentally.

In order to minimize the effect of meaning on MEMORY, Ebbinghaus invented the nonsense syllable, a consonant-

The work of 19th-century German psychologist Hermann Ebbinghaus legitimized the scientific approach to the study of higher mental processes.

vowel-consonant triplet that is pronounceable but is not a real word *(zat, wob, fij)*. His careful and thorough experiments, using himself as the only experimental subject, were published in *Memory: A Contribution to Experimental Psychology* (1885; Eng. trans., 1913), which proved to be enormously influential. He discovered the forgetting curve (the rate at which items are forgotten) and showed that the amount learned is linearly related to learning time. He later published work on brightness constancy and color vision and a new method for testing intelligence (1897).

Eberhart, Richard [eb'-ur-hart] An American poet and professor, b. Austin, Minn., Apr. 5, 1904, Richard Eberhart claims to write poetry by inspiration and with few revisions; he has made the conflict of intuition and intellect the subject of much of his work. His poetry seems to be tightly controlled, the product of demanding verse forms and rhyme schemes. His collections include *A Bravery of Earth* (1930), *Song and Idea* (1942), *Great Praises* (1957), *Collected Poems 1930–1986* (1986), and *Maine Poems* (1988). Eberhart won a Bollingen Prize in 1962 and a Pulitzer Prize in 1966 for *Selected Poems 1930–1965*.

Ebert, Friedrich [ay'-bairt] Friedrich Ebert, b. Feb. 4, 1871, d. Feb. 28, 1925, was the first president of the German republic established after World War I. The son of a tailor, by 1912 he had become a Social Democratic member of Germany's parliament, the Reichstag, where, as party leader during World War I, he loyally supported, despite misgivings, the government's often reckless leadership.

After the imperial regime had collapsed in 1918, Ebert accepted the presidency of what came to be called the WEIMAR REPUBLIC (named for the city where the constitution was drafted). Under his aegis, the moderates, with the support of the conservative bureaucracy and the still formidable army, overcame enormous difficulties and established a democracy that lasted until the onset of the Depression of the 1930s.

Ebionites [ee'-bee-oh-nyts] A Jewish-Christian sect that flourished until the 4th century, the Ebionites accepted Jesus Christ as the greatest of the prophets but not as the Son of God. They practiced a rigorous asceticism and stressed the binding character of the Mosaic Law. After the fall of Jerusalem in AD 70, the Ebionites settled in Transjordan but remained outside the mainstream of Christianity. They are often identified with the Nazarenes, a similar sect described by 4th-century writers.

Ebla [eb'-luh] The ancient city of Ebla, discovered among the ruins of modern Tell Mardikh, 55 km (34 mi) southwest of Aleppo, Syria, was an important trade center between the civilizations of Egypt and Mesopotamia. Sumerian and Akkadian tablets often mention Ebla, but its location remained unknown until 1968, when the Italian Archeological Mission in Syria uncovered a basalt statue bearing a 26-line cuneiform inscription that identified Ebla as the ancient name of the site. An archive of 42 clay tablets and fragments came to light in 1974. Soon after, the main palace archive was discovered; about 19,000 tablets and fragments have been unearthed there to date.

The tablets, dated *c.*2500 BC, represent the administrative records of a dynasty founded by King Igrish Khalam, which numbered six kings and lasted about 60 years. Employing Sumerian cuneiform, the records are written in a Semitic language now labeled Eblaite. The tablets include commercial treaties; bilingual vocabularies in Sumerian and Eblaite totaling 3,000 words; ritual and mythological texts; and lists of personal and place names. Linguistic analysis has revealed Eblaite to be a Canaanite language and thus to be closely related to Ugaritic, Hebrew, and Phoenician. Similar texts were found at UGARIT.

The Eblaite tablets illuminate the history of 3d-millennium BC Syria-Palestine, a region for which records of this period were formerly lacking. They indicate that the region was dotted with thousands of cities and towns and was not merely grazing land for nomadic herds as was previously thought. Some archaeologists believe the documents contain information relevant to the patriarchal stories in GENESIS.

ebony [eb'-uh-nee] The ebony wood of commerce is a hard, dark wood that takes a high polish. The name of the wood is derived from the true ebony, *Dispyros ebenum*, a large tree native to India and Sri Lanka. (A few closely related Asian and African trees are also known as ebonies.) The tree's black bark covers a white sapwood, but only the hard, brown or black heartwood at the core is the source of ebony. The brittle heartwood is easily carved and has long been used in applications ranging from marquetry to musical instruments to flatware.

Botanically, ebony is the name applied to the Ebenaceae, a family of trees and shrubs scattered widely throughout the tropical and warmer forested regions of the world. The genus *Dispyros*, to which true ebony belongs, is actually commonly known as the PERSIMMON genus. It is represented in the United States by persimmon species with wood of little commercial value, although the wood has been used in golf-club heads. Wood called ebony is also derived from some members of the unrelated pulse family, Leguminosae.

Ebro River [ay'-broh] The Ebro River, Spain's longest river, rises in the Cantabrian Mountains of northern Spain and flows southeast, reaching the Mediterranean Sea below Tortosa. Receiving more than 200 tributaries, the Ebro drains an area of 85,470 km^2 (33,000 mi^2) along its 910-km (565-mi) course. Numerous dams supply hydroelectric power and water for irrigation.

Ecbatana see HAMADAN

eccentricity In mathematics, eccentricity (*e*) is a characteristic of a CONIC SECTION; it is the constant ratio of the distance of any of its points *P* from a fixed point (called a *focus*) to the distance from a fixed line (called a *directrix*). The value of the eccentricity determines the shape of the conic. When e equals 0, the conic is a CIRCLE (or a point); when e is between 0 and 1 ($0 < e < 1$), it is an ELLIPSE; when $e = 1$, it is a PARABOLA; and when $e > 1$, it is a HYPERBOLA.

Eccles, Sir John Australian physiologist John Carew Eccles, b. Jan. 27, 1903, shared the 1963 Nobel Prize for physiology or medicine with Alan L. Hodgkin and Andrew F. Huxley for their contributions to understanding the transmission of nerve impulses. Eccles obtained his doctorate at Oxford University in 1929 and, in early research there, studied nerve functions in the spinal cord. He later extended this research to nerve cells in regions of the brain. Eccles was knighted in 1958.

Ecclesiastes, Book of [ee-kleez'-ee-as'-teez] Ecclesiastes is a book of wisdom writing in the Old Testament of the BIBLE. Its title is a Greek form of the Hebrew *Koheleth* ("preacher" or "speaker"). The author poses as Solomon, the archetype of the biblical wise man, but the book was not written before 350–250 BC.

Ecclesiastes is a philosophical essay on the meaning of human life. The author rejects all religious and ethical theories known to him, because they are contradicted by experience. He sees no divine plan in history, nature, or personal existence and argues that only relative satisfactions can be found in wealth, pleasure, family, friends, or work. The sole meaning of life is in living it fully by making the wisest possible choices. The few religious consolations expressed are widely attributed to a pious commentator.

Echeverría Álvarez, Luis [ay-chay-vay-ree'-ah ahl'-vah-rays, lou-ees'] Luis Echeverría Álvarez, b. Jan. 17, 1922, was president of Mexico from 1970 to 1976. He became active in the country's dominant Institutional Revolutionary party (PRI) and held a number of government posts, including that of minister of interior (1964–69) in the government of Gustavo Díaz Ordaz. As president, Echeverría faced problems of inflation, economic instability, and political violence.

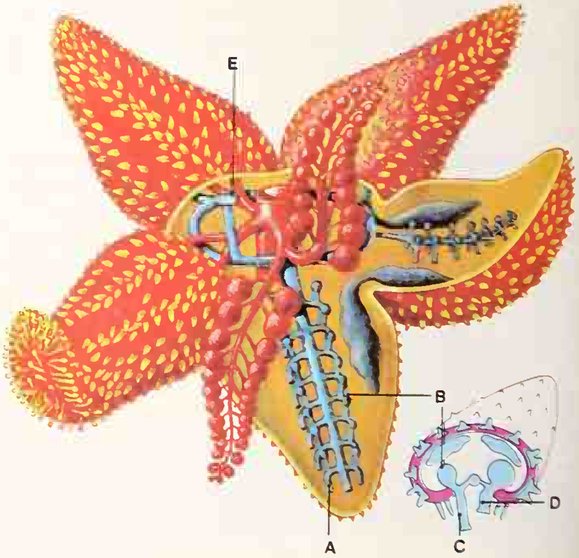
echidna see SPINY ANTEATER

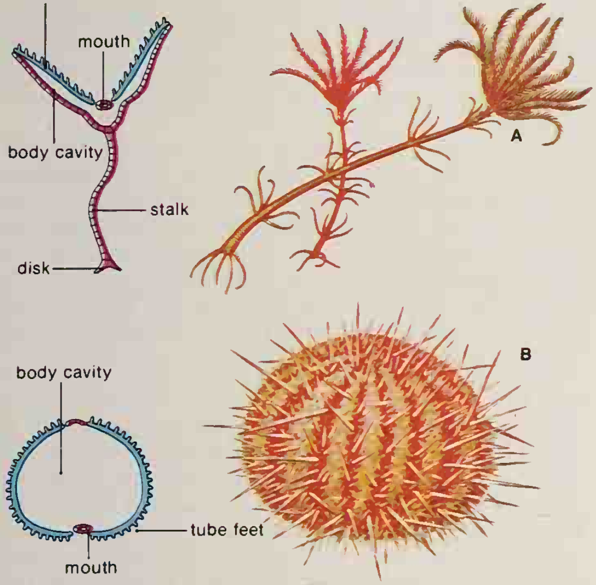
echinoderm [ee-kine'-oh-durm] Echinoderms, phylum Echinodermata, are marine invertebrate animals with an internal skeleton composed of calcium carbonate and a unique water-vascular system. The group includes SAND DOLLARS, SEA CUCUMBERS, SEA URCHINS, STARFISH, brittle stars, feather stars, and sea lilies. Fossil echinoderms are conspicuous from the lower Cambrian Period onward. Approximately 13,000 fossil species and 6,000 living species are known.

Echinoderms are directly useful to humans in many ways. The gonads (sex glands) of sea urchins and the body walls of sea cucumbers are eaten in many parts of the world, the swimming larval stages of sea urchins are used extensively as experimental subjects, and some chemicals extracted from sea cucumbers are useful in pharmacology. Echinoderms have a detrimental side as well: certain starfish are serious predators of commercially useful oysters and clams; others can cause great short-term damage to coral reefs.

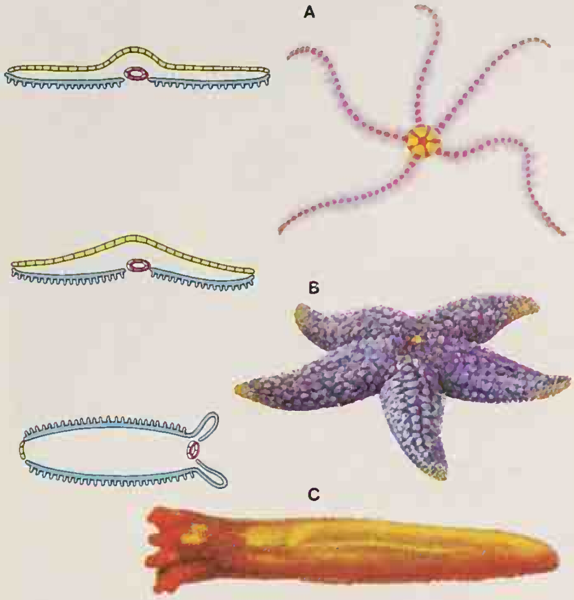
Structure. All living echinoderms have a fivefold symmetry. The internal skeleton may range from a rigid shell, or test, as in sea urchins, to scattered microscopic ossicles, as in the soft body wall of sea cucumbers. The water-vascular system consists of a system of fluid-filled vessels. A hollow ring around the mouth gives rise to five main branches, which extend outward into arms or run

Starfish, like other echinoderms, have a body plan that includes an internal calcium-carbonate skeleton; a water-vascular system (blue), *used for locomotion and suction; and a digestive system* (red), *which includes a projectable stomach. In the five armed starfish, the water-vascular system consists of a central, hollow ring with five branched tubes, one for each arm. At the end of each branch is a tube foot* (A), *with a bulblike ampulla* (B) *at its top and a sucker disk at the bottom. When the ampulla contracts, fluid is forced into the tube foot, which lengthens it* (C); *when the extended tube foot touches an object, the center of its sucker disk is pulled up, creating a vacuum and suction beneath it. Muscles in the tube foot then shorten* (D), *forcing fluid back in the ampulla, while simultaneously either drawing the starfish forward or exerting a pulling force on its prey. Although a sieve plate* (E) *leads from outside to the central ring, it is not certain whether the plate provides water for the water-vascular system. Starfish feed by everting their stomachs.*





The sea lily (A) *and the sea urchin* (B), *both echinoderms, differ externally but contain similar features, such as tube feet. The sea lily may be thought of as an upside-down sea urchin on a stalk (compare their gross anatomies at left). Sea lilies commonly live in ocean deeps, where they anchor themselves by a disk at the base of the stalk. Sea urchins live from intertidal shallows to ocean depths.*



A brittle star (A), *a starfish* (B), *and a sea cucumber* (C) *share a similar anatomy, including calcium carbonate plates embedded in the skin* (yellow), *tube feet* (blue), *and a mouth* (red). *The brittle star and the starfish live mainly on coastal floors of oceans, although some species exist in deep sea. The sea cucumber typically burrows in the sands of coastal waters, where it feeds on tiny, organic particles.*

along the inside of the body wall in armless forms. The branches give rise to numerous tube feet, which are used for locomotion, capture of prey, sensory perception, and respiration. The system is in contact with the surrounding seawater by means of a madreporite, or sieve plate, which opens into the ring vessel through a calcified stone canal. Fivefold symmetry is also evident in the nervous, circulatory, and muscle systems. The average life span of an echinoderm is about five years.

Classification. The five living classes of echinoderms are usually assigned to three subphyla, as follows: (1) Subphylum Asterozoa: classes Asteroidea (starfish) and Ophiuroidea (brittle stars). Both classes have a star-shaped body, with arms growing in one plane from a central disk. The mouth is central, lying on the same side of the body as the tube feet. In asteroids the arms are hollow, containing parts of the digestive and reproductive systems. In ophiuroids the arms are essentially solid, and major organ systems are restricted to the small central disk. All ophiuroids and some asteroids lack an anus; waste products are egested through the mouth. (2) Subphylum Echinozoa: classes Echinoidea (sea urchins and sand dollars) and Holothuroidea (sea cucumbers). For members of these classes, the body is somewhat spherical, cylindrical, or discoid. They have no arms, and the main branches of the water-vascular system radiate outward to form meridians on the inside of the body wall. The echinoids have a strong, hollow skeleton composed of numerous ossicles sutured together. The test carries conspicuous movable spines. The sea cucumbers have reduced skeletons, and the body is generally soft and often wormlike, lacking spines. Unlike other living echinoderms, sea cucumbers have a ring of feeding tentacles around the mouth. (3) Subphylum Crinozoa: class Crinoidea (sea lilies and feather stars). These echinoderms have a cup-shaped body, or theca, which gives rise to five or more arms that carry feeding extensions of the water-vascular system. Sea lilies have a stem that supports the body above the seafloor. Feather stars lack stems as adults, and attach themselves to the seafloor by means of clawlike structures called cirri.

Life Histories. Echinoderms are usually restricted to the seafloor, although a few deep-sea-swimming sea cucumbers are known. Echinoderms occur in a wide variety of habitats, from the shore to the deepest ocean trenches, where they may cling to upper- or undersides of rocks or corals, or live on or in sand or mud. CRINOIDS and some asteroids, ophiuroids, and holothuroids feed by extending their arms or tentacles into the surrounding water and capturing small organisms. Some starfish are active predators. Others ingest organic material from the seafloor. Some holothuroids swallow large quantities of mud, extract the organic material, and egest the waste.

The method of reproduction varies. Some echinoderms release eggs and sperm into the water; after fertilization, the zygote develops into a swimming larval stage, which eventually metamorphoses into a juvenile. Others omit the larval stage and develop more or less directly into juveniles.

Another notable feature of echinoderms is their excellent power of regeneration. They easily repair injured tissues and replace lost parts. Some sea cucumbers can eject their digestive system and associated organs when disturbed, and grow a new set within a few weeks.

Echo (mythology) In Greek mythology, Echo was a mountain nymph who was given a speech impediment by the jealous goddess HERA. On one occasion Hera was detained by Echo's lengthy conversation until she realized that Echo's purpose was to help Zeus, Hera's husband, continue his dalliances with mountain nymphs undisturbed. So she decreed that Echo's speech would henceforth be limited to repeating what others said. Because of an unrequited love for NARCISSUS, Echo pined away until only the sound of her voice remained.

Echo (satellite) see COMMUNICATIONS SATELLITE

echolocation Echolocation is the use of the echoes of sounds produced by certain animals to detect obstacles in their paths and perhaps to locate food. The term *echolocation* was coined (1944) by Donald R. Griffin to describe this process. The list of echolocators includes many bats, porpoises, some whales, several species of birds, and some shrews. Blind people and animals that live where the lighting is unpredictable also use a form of echolocation.

Sounds used in echolocation may be produced in the voice box, the mouth, or some other part of the head, and in all cases highly refined auditory systems detect returning echoes. For echolocation to work, each outgoing pulse of sound must be registered in the organism's brain, where it will be compared to its echo. Porpoises, birds, and some bats use loud orientation sounds, which pose a problem of self-deafening. The problem is resolved in bats by neural and muscular modifications in their auditory system.

Echolocation is mistakenly associated with high-frequency sound, or ultrasound. In fact, the echolocation sounds of oilbirds and cave swiftlets are quite audible to the human ear, as are those of some bats. Most bats use pulses of ULTRASONIC sound (inaudible to humans) because high-frequency sounds provide better resolution of targets than do lower-frequency sounds. Insectivorous bats use a wide array of echolocation strategies involving changes in loudness and frequency.

A bat judges the distance to its prey by reflecting sounds it has emitted. Echolocation is also used to navigate in dark caves or at night.

Eck, Johann [ek] Johann Eck, b. Nov. 13, 1486, d. Feb. 10, 1543, was a German Roman Catholic theologian and the principal contemporary opponent of Martin LUTHER. His *Obelisci* (1518) were written in reply to Luther's 95 theses, and he engaged Luther in public debate in Leipzig in 1519. As a papal legate in 1520, Eck was largely responsible for the papal bull *Exsurge Domine* that excommunicated Luther.

Eckhart, Meister [ek'-hart, my'-stur] Meister Eckhart, *c.*1260–*c.*1327, was a German theologian and mystic. Eckhart taught what has been called speculative or essential mysticism. His basic doctrine was that only God actually exists and that any creature exists only insofar as its soul is in contact with God; this vital contact is accomplished only when the individual is freed from sin. By 1326, Eckhart was in trouble with church authorities concerning his doctrines; his sermons were examined by the Inquisition. Only a few propositions of his doctrine were finally condemned by Pope John XXII in 1329.

eclampsia see PREGNANCY AND BIRTH

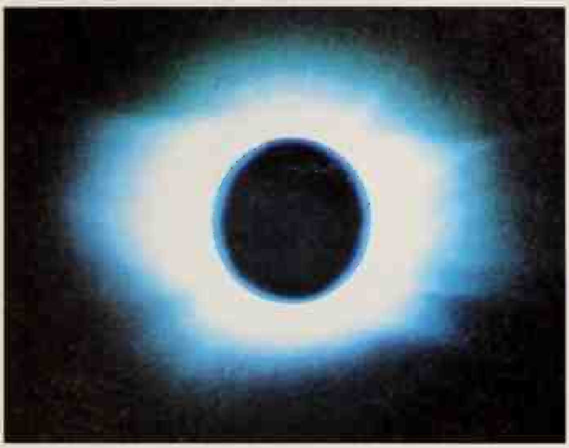
eclecticism [eh-klek'-tih-sizm] Eclecticism, from the Greek *eklektikos* ("selective"), is the practice of mixing elements diverse in style in a single work of art. No new artistic synthesis emerges from the several styles appropriated; rather, the elements combined retain a certain distinctiveness and recall their separate origins. Although the term was first applied to art by Johann WINCKELMANN (1764), the practice is ancient. The consciously eclectic artist seeks to bring together the strengths of several masters or models, or the outstanding traits of different traditions; thus the Venetian Paolo Pino urged in 1548 that the drawing of Michelangelo be wedded to the coloring of Titian. Later ages, prizing signs of spontaneity and inspiration in art, have grown suspicious of the imitative procedures inherent in Pino's and similar prescriptions and have made the term *eclectic* pejorative, implying the absence of unity in a work (which is judged stylistically heterogeneous) and of originality in an artist (who betrays a failure to digest his or her antecedents fully).

A variety of eclecticism may be deliberately employed for comic effect, as in PASTICHE or potpourri. Some contemporary COLLAGES may also be regarded as eclectic forms.

eclipse [ee-klips'] An eclipse is observed when a celestial body is seen to move in front of another. The SUN is eclipsed when the Moon passes in front of it. The MOON is eclipsed when the Earth casts its shadow on the Moon. The Galilean satellites of Jupiter eclipse one another. Some close BINARY STARS are eclipsing binaries. The word *eclipse* is a general one; when the Moon moves in front of a star, however, the event is called an OCCULTATION, and when Mercury or Venus moves between the Earth and the Sun, the event is called a transit.

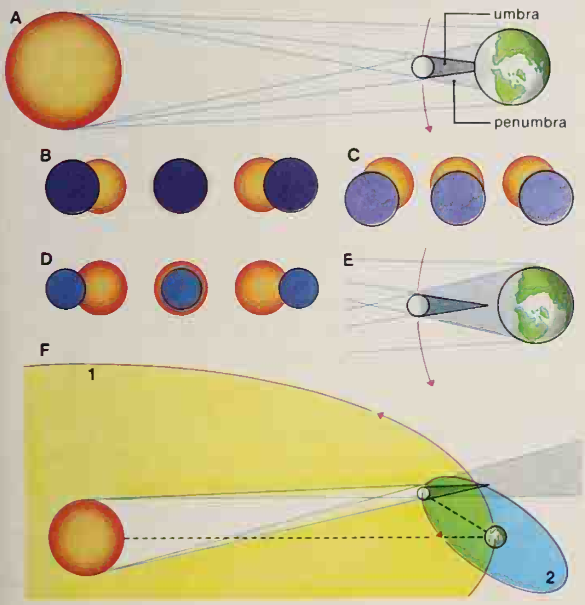
Eclipses of the Sun and Moon have long made a deep impression on humankind. The blotting out of light from a familiar and apparently predictable source was generally considered a bad omen. Predicting eclipses was one of the duties of ancient Chinese astronomers, who labored under the threat of death if they failed. Today eclipses can be predicted to within seconds, and interest in them is both scientific and aesthetic.

Partial, Total, and Annular Eclipses. The shadow cast by a body has two components. In the case of the Moon, these are (1) the umbra—a cone with its apex an average of 373,000 km (231,700 mi) from the Moon, and in which the Sun is entirely obscured; and (2) the penumbra—a region becoming wider the farther it is from the Moon, and in which the Sun is partially obscured. Since the average distance between the Earth and Moon is about 4,800 km (3,000 mi) greater than the length of the umbra, the tip of the umbra does not, on the average, quite reach the Earth's surface. But because of the eccentricity of the Moon's orbit, the Moon can come closer than average, and the umbra can intersect the Earth's surface in a circle with a diameter as great as 269 km (167 mi). As the umbra sweeps over the surface of the Earth, the longest time for a fixed observer to remain inside it is about 7½ minutes. An observer within the umbra sees a total eclipse; one in the penumbra sees a partial eclipse. A solar eclipse is called annular when the tip of the umbra fails to reach the Earth; then only the center of the Sun is obscured, leaving a bright ring, or annulus.



The faint, outer atmosphere, or corona, of the Sun becomes visible during a total solar eclipse. Its shape and dimensions depend on solar activity.

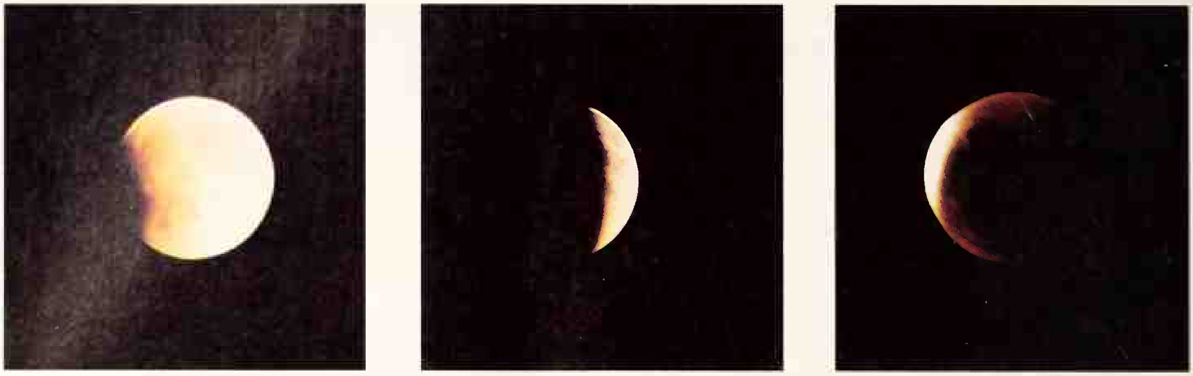
Solar eclipses result when the Moon passes directly between the Earth and the Sun. The Moon casts two separate shadows: an umbra and a penumbra (A). *When any area of the Earth enters the Moon's umbra, observers there view a total solar eclipse* (B). *Anyone within the penumbral region sees a partial solar eclipse* (C). *The Sun's rim is visible around the Moon during an annular eclipse of the Sun* (D), *which occurs when the umbra does not reach the Earth* (E). *Eclipses are not seen every month; the Moon's umbra usually passes above or below the Earth* (F) *as a result of a 5° inclination between the Earth's orbit about the Sun* (1) *and the Moon's orbit about the Earth* (2).



An eclipse of the Moon can be total or partial, but not annular. It can be observed from any point on the Earth where the Moon would be visible. The Moon is never wholly dark during a lunar eclipse because of sunlight refracted by the Earth's atmosphere; the amount of indirect illumination depends on the atmospheric conditions at the time.

Conditions for Occurrence. An eclipse of the Sun can take place only at new Moon, and that of the Moon only at full Moon; and the Sun, Earth, and Moon must be very nearly, if not precisely, aligned. Because the orbit of the Moon is inclined at about 5° to the ECLIPTIC, during most months new and full Moon will occur when the Moon is either too far north or south of the Sun for an eclipse to take place. But when the Sun is close to the ascending or descending node of the Moon's orbit, an eclipse is possible.

Scientific Importance. Partial eclipses of the Moon and the Sun are of little scientific interest. Total solar eclips-



A total lunar eclipse occurs when the Earth passes between the Moon and the Sun, such that the Moon moves through the Earth's umbra (left to right). *During totality and just after the Moon reappears* (right), *the area within the umbra is visible as a faint red circle.*

es are of great importance, and are also beautiful. While a small part of the Sun's photosphere is still visible, the sky appears bright and milky because of scattered sunlight. At this stage it is still dangerous to look toward the Sun, and many people have suffered irreparable eye damage when doing so. Just before totality, the last sunlight gleams through irregularities on the Moon's surface, giving the phenomenon called Bailey's beads. Then, suddenly, the sky darkens and stars are visible.

Most remarkable of all, the solar corona becomes visible during this period of darkness; this is sometimes accompanied by solar prominences extending like red tongues from the chromosphere. For a long time these could be studied only at times of solar eclipse, but the coronagraph and spectroheliograph now make it possible to study the inner corona and prominences at other times. The solar chromosphere can be observed as a thin red arc in the moments just after the photosphere disappears and just before it reappears. Observed through a prism, this light breaks up into bright arcs called the flash spectrum.

One of the most famous tests of Einstein's theory of general relativity was made in 1919 during a solar eclipse. Einstein had predicted that a ray of light just grazing the surface of the Sun would change direction by 1.75 seconds of arc. The field of stars near the Sun was photographed during total eclipse; the same field had been photographed months earlier when it was in the night sky. The photographs were compared, and on this occasion, as well as on many similar occasions since, the observations were consistent with Einstein's prediction.

SOLAR ECLIPSES, 1991–2002

Date of Occurrence	*Type*	*Date of Occurrence*	*Type*
Jan. 15, 1991	Annular	Oct. 12, 1996	Partial
July 11, 1991	Total	Mar. 9, 1997	Total
Jan. 4, 1992	Annular	Sept. 2, 1997	Partial
June 30, 1992	Total	Feb. 26, 1998	Total
Dec. 24, 1992	Patial	Aug. 22, 1998	Annular
May 21, 1993	Partial	Feb. 16, 1999	Annular
Nov. 13, 1993	Partial	Aug. 11, 1999	Total
May 10, 1994	Annular	June 21, 2001	Total
Nov. 3, 1994	Total	Dec. 14, 2001	Annular
Apr. 29, 1995	Annular	June 10, 2002	Annular
Oct. 24, 1995	Total	Dec. 4, 2002	Total
Apr. 17, 1996	Partial		

ecliptic [i-klip'-tik] The ecliptic is the plane of the Earth's orbit around the Sun, or the intersection of this plane with the celestial sphere. The Sun appears to make a complete circuit around the ecliptic every year. The constellations around the ecliptic make up the ZODIAC. The ecliptic is inclined by an angle—the obliquity of the ecliptic—of about 23.5° to the equator; the inclination influences the character of the seasons. Planetary perturbations cause the ecliptic to change very slowly; for precise work the time of observation (epoch) relative to the ecliptic must be stated.

eclogue [ek'-lawg] Derived from the Greek word for "selection," eclogue originally was merely a short poem or a passage of a longer one in the form of a dialogue or soliloquy. The term was subsequently applied to VERGIL's bucolic, or pastoral, poems. During the Renaissance it often referred to a dialogue in verse with a pastoral theme, such as Spenser's *Shepheards Calendar* (1579). In the 18th century the term denoted the form but had little to do with pastoral. The 20th-century eclogue has included a wide variety of poetry, such as Robert Frost's "Build Soil."

See also: PASTORAL LITERATURE.

École des Beaux-Arts [ay-kohl' day bohz-ar'] The École des Beaux-Arts, founded in 1648 by Charles Le Brun as an academy of painting and sculpture, is the French national school of the fine arts. The school took its present form in 1795 after merging with the Academy of Architecture, founded in 1671 by Jean Baptiste COLBERT. In 1864 it was placed under state control by Napoleon

III, and architects trained there played a large part in the revival of classical and Renaissance motifs used in many public buildings of Second Empire Paris, including Charles Garnier's Opéra. Many eminent French artists have studied and taught at the school, whose influence has often extended beyond France. Although a fundamentally conservative institution, many notable innovators, including Édouard Manet, Claude Monet, and Henri Matisse, have attended its classes, and its curriculum has undergone several reforms. Tuition is free for all students who pass the rigorous qualifying examination, and outstanding graduates compete for the Prix de Rome, a scholarship for advanced study in Italy.

See also: ACADEMIES OF ART.

ecology Ecology is the scientific study of the interrelationships of plants, animals, and the environment. In recent years, the word has sometimes been misused as a synonym for environment. The principles of ecology are useful in many aspects of the related fields of conservation, wildlife management, forestry, agriculture, and pollution control.

The word *ecology* (Greek, *oikos*, "house," and *logos*, "study of") is generally believed to have been coined by the German naturalist Ernst Haeckel, who used and defined it in 1869. The historical roots of ecology lie not only in natural history, but in physiology, oceanography, and evolution as well. Ecology is variously divided into terrestrial ecology, fresh-water ecology (limnology), and marine ecology, or into population ecology, community ecology, and ecosystem ecology.

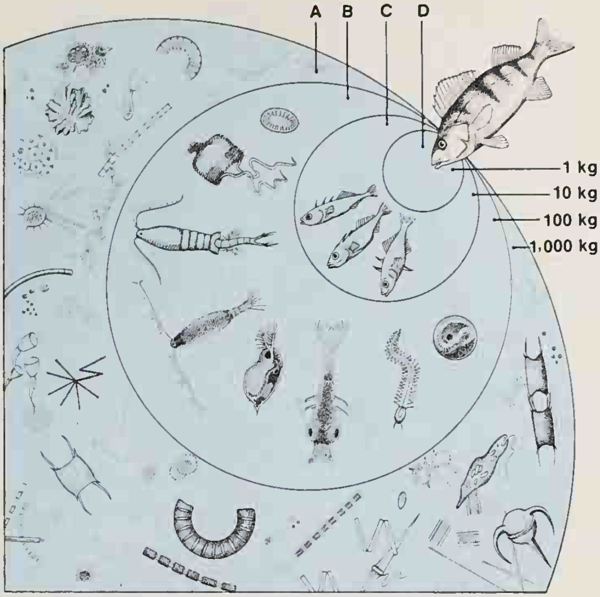
Ecological Classification of Organisms

Ecologists commonly classify organisms according to their function in the environment. Autotrophs ("self-nourishers," also called producers), which are mainly green plants, manufacture their own food from carbon dioxide, water, minerals, and sunlight, whereas heterotrophs—a wide assortment of organisms—lack the metabolic machinery to synthesize their own food and must obtain it from other sources.

Some heterotrophs—the herbivores—eat plants, and some—the carnivores, or predators—eat animals. Some, called omnivores, eat both plants and animals; others eat only dead plants and animals. Some, called scavengers, eat large dead organisms. Some smaller heterotrophs, such as bacteria and fungi, feed on dead organisms; they are called decomposers. Parasites eat living organisms, but, unlike predators, do not devour them at one time. Parasites include forms such as ticks and fleas, which live on their hosts, and others, such as tapeworms, roundworms, and bacteria, which live within their hosts.

Communities

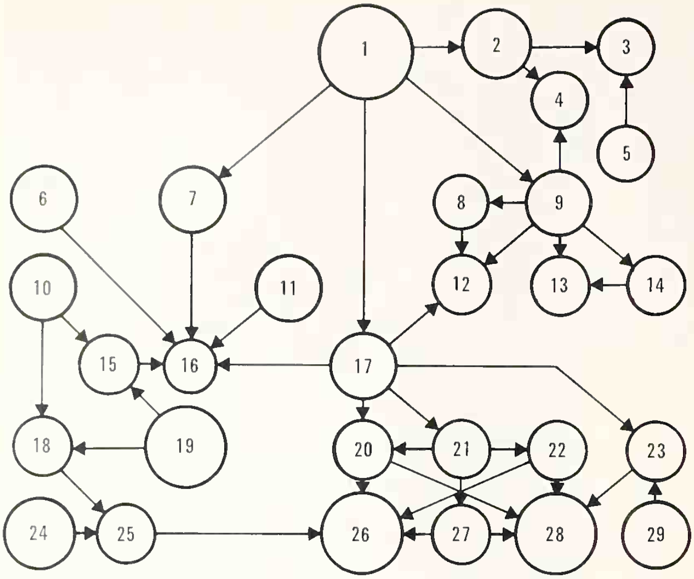
Organisms live together in assemblages called communities. Some communities are very small, such as those composed of invertebrates and decomposers living within a rotting log. Others may be as large as an entire forest. The most extensive communities, called BIOMES, occupy wide geographic areas. The major biomes are arctic TUNDRAS, northern coniferous FORESTS, deciduous forests, GRASSLANDS, DESERTS, and tropical JUNGLES AND RAIN FORESTS. The distinctive appearance of each biome is generally determined by the predominance of characteristic plant species, but the animals that are characteristically associated with it also contribute to its distinctiveness.



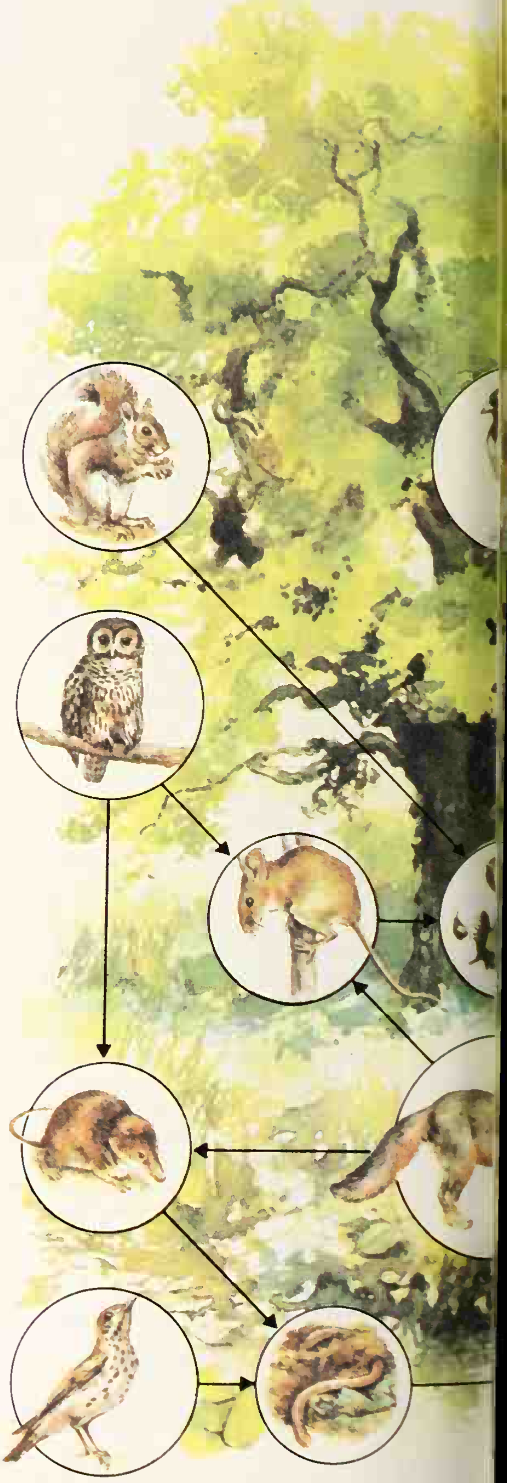
In a typical aquatic food chain, the producers are microscopic plants, or phytoplankton (A). *These are eaten by herbivores, such as water fleas and other zooplankton* (B), *which are in turn consumed by small carnivores such as sticklebacks* (C). *Perch and other secondary carnivores* (D) *live on these smaller fishes. About one-tenth of the biomass and food energy at each step in the pyramid is transferred to the next trophic level.*

Communities are composed of both plants and animals. Each species is distributed according to its own biological requirements, which may be affected by other species. For example, sugar-maple seedlings require shade and may therefore mature easily in dense forests, whereas seedlings of eastern white pine require full sunlight for vigorous growth. Therefore, some species are sometimes associated with each other, but the exact degree of dependence is difficult to determine and has led to differences of opinion concerning the extent to which communities are discrete entities. By tabulating all plants found along a line passing through adjacent communities on mountainsides, it has been shown that the distribution pattern of each species is independent of most others, suggesting a continuum rather than a few discrete communities.

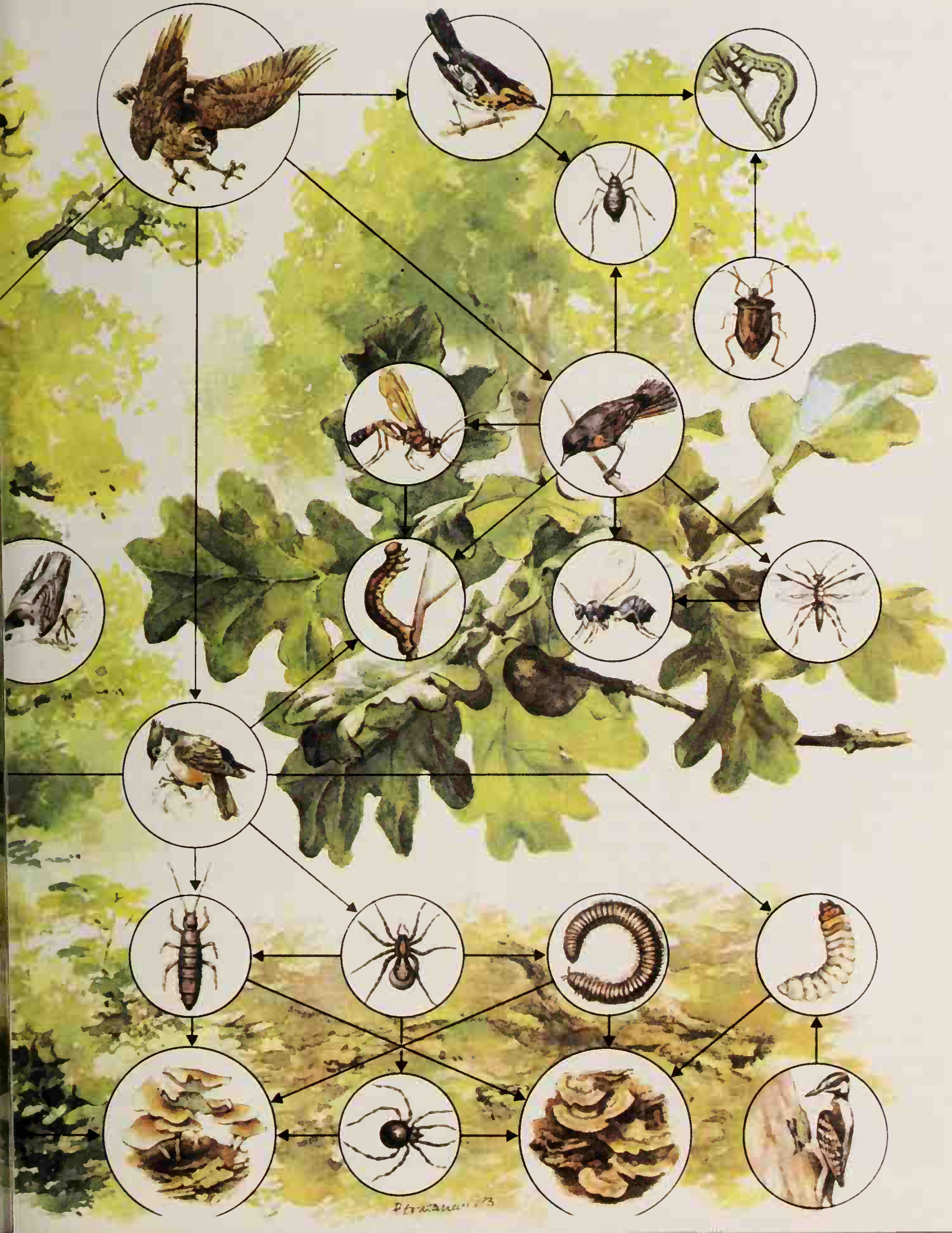
Communities also exhibit vertical stratification or layering. In tropical rain forests, for example, the tallest trees, called emergents, grow above the canopy trees; below the canopy trees are shorter trees; below the shorter trees are shrubs; and covering the forest floor is a layer of



1 Broad-winged hawk
2 Blackburnian warbler
3 Winter moth caterpillar
4 Aphid
5 Common shield bug
6 Gray squirrel
7 Rufous-sided towhee
8 Ophion (parasite)
9 American redstart
10 Barred owl
11 White-breasted nuthatch
12 Mottled umber moth caterpillar
13 Gall wasp
14 Braconid wasp (parasite)
15 Woodmouse
16 Acorns, Beechnuts
17 Tufted titmouse
18 Common shrew
19 Gray fox
20 Springtail
21 Wolf spider
22 Millipede
23 Beetle larva
24 Woodthrush
25 Earthworm
26 Litter (Fungi and bacteria)
27 Mite
28 Dead wood (Fungi and bacteria)
29 Hairy woodpecker



The illustrated food web is typical of the deciduous forests of eastern North America and similar to those found in eastern Asia and western Europe. Deciduous forests occur in temperate climates with marked warm and cold seasons and adequate rainfall. Common trees include oak, beech, maple, ash, and poplar, all broad-leaved species that shed their foliage each winter as an adaptation to the cold season. Each spring, before new leaves appear on the trees, an herbaceous ground layer flourishes. Leaves supply abundant food to herbivorous insects, especially caterpillars, which in turn are eaten by insectivorous birds. Other plant products, seeds such as acorns and beech nuts, are eaten by some birds and such rodents as mice and squirrels. These smaller birds and mammals provide nourishment for foxes and birds of prey. Fungi and bacteria act as decomposers of dead plant and animal materials, recycling nutrients in the ecosystem. The decaying material is consumed by various worms, insects, mites, and millipeds. The diversity of animal species in a deciduous forest is greater than in a coniferous forest because of an increased richness of the plant community and a more varied range of niches.



herbaceous (nonwoody) plants growing in soil inhabited by FUNGI and BACTERIA. Some characteristic animals are also found in each of the strata, such as toucans in the canopy, but most animals range through several strata.

Another aspect of communities is temporal (time) structure. Some species of animals are diurnal (active in daytime), some are nocturnal (active at night), and still others are crepuscular (active at twilight hours). This structure allows more organisms to occupy the same area without interfering with each other. In addition to these daily activity patterns, there may also be seasonal ones. In temperate areas, for example, frogs of different species use ponds to reproduce at various times throughout the spring. This prevents excessive competition between species for space and food at any one time.

The number of species within a community is called species diversity. Species diversity has two components, richness and evenness. If there are many species in a community, it is said to have a rich diversity. All species, however, are not always equally represented. If, as commonly happens, only a few species are abundant, the diversity is said to be uneven. If a community is made up of many species and each is relatively abundant, the community is considered relatively stable, because the reduction or removal of any one species would be far less important than the loss of an abundant species in a community where only a few are numerous.

If a community that has been disturbed by a disaster such as fire, flood, windstorm, volcanic eruption, plow, or bulldozer, is left undisturbed for a long time, it will eventually restore itself; this process is called succession. A forest completely destroyed by fire may take hundreds or thousands of years to become completely renewed, depending on the climate, the nature of the SOIL, and other environmental factors.

The first species to invade a destroyed area are called pioneers. These opportunistic species usually have good means of dispersal and high reproductive capacities. Lichens, grasses, and other herbaceous species are the most common pioneers, but trees such as cottonwood, elm, aspen, and silver maple, which produce abundant windblown seeds, are sometimes found as well. Availability of sources of spores or seeds at the periphery of the disturbed area, as well as the suitability of the disturbed site for each species, determines the species composition of the first community formed. The invading species begin to change the environment by increasing the organic content of the soil with their dead parts and excreted wastes, creating shade, and changing moisture conditions. Some species harbor nitrogen-fixing bacteria that release nitrogenous compounds into the soil and thereby fertilize it.

In the course of succession, conditions are generally made more suitable for new types of organisms that use less energy for reproduction and more energy to maintain themselves. These species gradually win out in competition with the pioneers. Collectively, they produce a new community. The process of replacement of species may continue for a long time, resulting in several visibly different communities, although the changes occur gradually. Eventually a point is reached at which the environmental and species changes are minimal and species diversity is high. This relatively stable community is called a climax community.

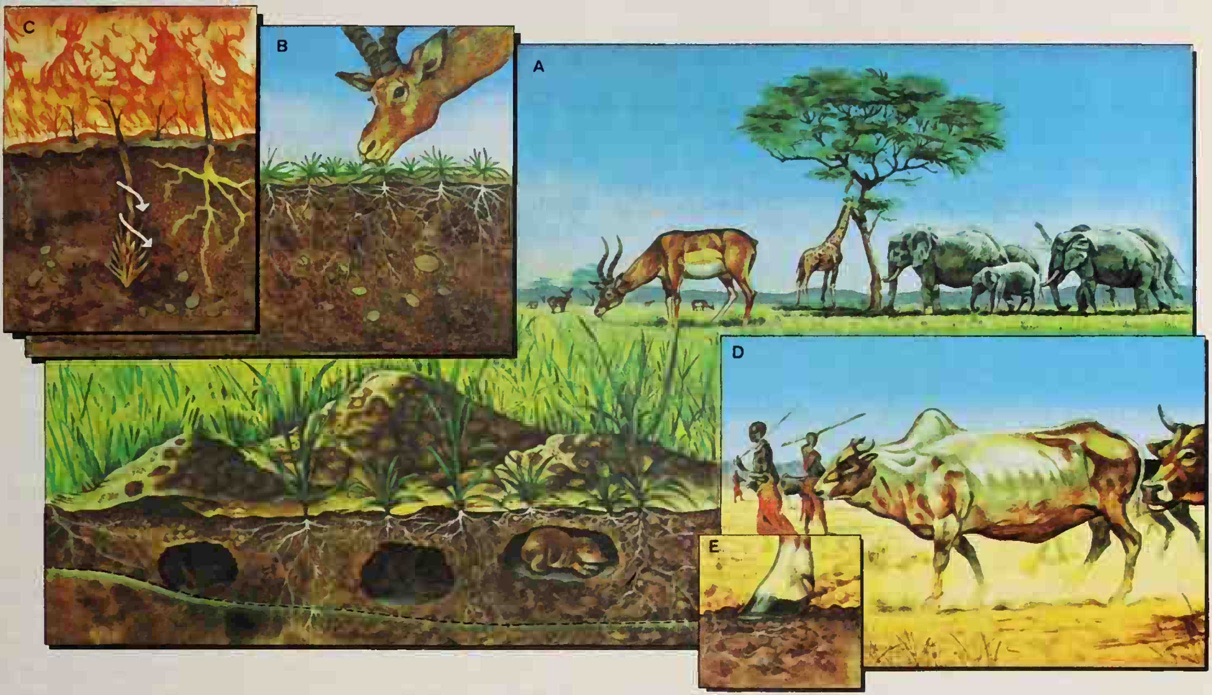
Ecosystems

Many ecologists study communities in the context of an ecosystem, which includes interactions involving mineral cycling, energy flow, and population control. The study of ecosystems facilitates a functional approach to ecology.

One of the major aims of ecological research is to determine how organisms retain and recycle the MINERALS within an ecosystem. All minerals used by organisms are important, but some, such as those rich in nitrogen and phosphorus, are used in larger amounts, or may be less available than others. Herbivores speed the recycling of minerals by eating plant parts and then excreting some of these materials; minerals in the plants are thus returned to the soil faster than if the plants had not been eaten. Scavengers help by breaking down large dead organisms faster than bacteria or fungi alone, and bacteria and fungi eventually break down fecal material and other smaller organic matter into its mineral components. Carnivores feeding on herbivores also help to recycle the minerals found in the bodies of herbivores. Roots of plants may absorb these materials for reuse or may absorb minerals from soil made available by WEATHERING processes. Some minerals, however, will escape from the ecosystem and eventually end up in the oceans.

A second functional aspect of ecosystems is energy flow, conceived of as occurring within a pyramid, the base of which is composed of producers and above them a smaller number of herbivores and a still smaller number of carnivores. In ecosystems, all energy comes from the Sun. A small part of this energy (1% to 2%) is captured by plants and stored as energy-rich chemical bonds in the compounds of their PROTOPLASM. Only 1% to 20% of this energy is passed on to herbivores, and a similar energy loss occurs at each higher level in the pyramid of food levels. This phenomenon has three important effects: it limits the possible number of such levels, usually to five; it affects the size of the organisms in each succeeding food level, so that carnivores are usually larger than other species; and it absolutely limits the amount of energy available to organisms in each level.

Energy is lost at each food level for several reasons: heat is created as chemical bonds are changed into mechanical energy or other forms; energy is used for metabolic processes (especially respiration); the organisms at one level are not completely consumed by those at the next higher level; and food passing through animals' digestive tracts is not completely digested. For example, only about 10% of the leaves of trees, and even less of the roots and stems, are eaten by insects. Much of the energy that does not pass through herbivores or carnivores eventually passes through scavengers and decomposers. Some of this energy may then flow into predators that feed on these forms and may thereby be passed back into the main energy pyramid. Aphids excrete much of the sugary sap that they suck from veins in leaves, which then appears



Tropical grasslands (A) *are balanced ecosystems that support a variety of herbivores. Grasses are adapted to drought, fire, and grazing animals, which often eat vertical shoots but leave some horizontal leaves* (B). *Even if all leaves are destroyed, grasses may regenerate from roots or runners. Red oat grass,* Themeda triandra (C), *common in Africa, has seeds which expand and contract with heat; this motion twists the seed deep into the soil, away from possible fire damage. Humans have threatened natural grasslands by replacing native animal species with more concentrated domestic herds* (D) *which overgraze the grasses, compact the earth, and damage the roots of grass plants* (E).

as honeydew beneath the trees. When glucose is respired in cells, no more than 50% of its energy is converted into other chemical bonds; the rest is given off as heat.

The amount of energy stored in a given unit of time by green plants as a result of PHOTOSYNTHESIS is called primary productivity. The amount of energy stored by animals in a given unit of time is called secondary productivity. The percentage of energy that passes from one food level to the next is called ecological efficiency.

A third major ecological function is population regulation. One of the functions of herbivores is to control plant populations. Predators and parasites may also serve as controls over organisms they eat. Insects that prey on other invertebrates may indeed control their prey, which often cannot escape or hide. Such is the case with the ladybird beetle, which can control such pests as the mealy bug. With larger animals, such as foxes and rabbits, the situation is much more complex; the control of rabbits, for instance, may involve density-independent factors, such as severe winters and drought, as well as density-dependent controls, such as predators and parasites.

Evolution and Adaptation

Darwin's theory of EVOLUTION was essentially ecological; he postulated that the organisms which will survive to reproduce are those that are best adapted to their environment. Ecologists are concerned with how organisms adapt to their environment in order to survive. The ecological functions of an organism are said to constitute its niche. For example, an insect may be a predator, but it may not prey on organisms much larger or much smaller than itself. Also, diurnal predators normally do not capture organisms that are nocturnal or that live in HABITATS unsuited to the predator.

Many ecologists are proponents of a principle called competitive exclusion, which states that each niche can be occupied by only one species, because when a required resource is limited and two or more species compete for it, one of the species will be eliminated unless it can evolve to occupy a slightly different niche.

Modern Trends and Future Developments

One of the major trends in ecology is the increased use of mathematical modeling, which often requires the use of computers. Mathematical formulas are used to simulate population fluctuations, mineral cycling, and energy flow. Models can be used to discover where human knowledge is inadequate, to aid in making generalizations and formulating ecological principles, and to help predict the fate of ecosystems under given sets of circumstances.

In the growing field of systems ecology, scientists use theoretical analysis and experimental methods to study the disruption of ecosystems and the dynamics of their reconstruction. Ecologists are more and more involved in solving problems caused by increased human population, increased pollution, increased need for energy, and increased attempts to destroy ecosystems for human use. Ecology will be needed to help solve the problems of feeding the world's people, as well as to solve conservation problems ranging from the management of all kinds of native plants and wildlife to the preservation of ENDANGERED SPECIES.

See also: ENVIRONMENT; NUTRIENT CYCLES; POPULATION DYNAMICS.

econometrics [ee-kahn'-oh-met'-riks] Econometrics is a branch of economics that seeks to measure and correlate the relationships among economic variables. It combines economic theory expressed in mathematical form with statistical methods. Econometrics utilizes computers to analyze systematically economic data under study.

Well-known examples of econometric analysis are the models of the U.S. national economy developed at the Wharton School of the University of Pennsylvania, the Massachusetts Institute of Technology, the Federal Reserve Board, and other centers. These models are used to analyze economic fluctuations and to predict changes in national income and employment. They are constructed of equations describing relationships among prices, wages, output, employment, and capital investment in different sectors of the economy. The answers obtained, of course, depend on the assumptions underlying the equations.

Economic Opportunity Act see WAR ON POVERTY

economic planning Economic planning, as a national policy, is the direction or control of key economic decisions by a central governmental authority. The opposite of economic planning in this sense is the free market, in which economic decisions are made only by buyers and sellers.

Most countries in the 20th century have evolved some form of government economic planning, whether it is the relatively limited economic guidelines characteristic of most private-enterprise economies, the more precise frameworks of moderate socialistic systems, the far-reaching objectives and programs of developing countries, or the highly detailed and centralized planning in Communist countries.

Planning in Capitalist Countries. In the MIXED ECONOMIES of capitalist countries, governments take measures in an attempt to smooth business fluctuations, increase economic growth, direct the allocation of critical resources, encourage the development of backward regions, and redistribute income. The private sector, however, remains the chief source of economic initiative. Only rarely will the government of a capitalist country intervene directly in the affairs of individual firms or consumers. Governments try to influence the economy by tariffs and import quotas, changes in FISCAL POLICY and MONETARY POLICY, expenditures on public works, subsidies to certain industries, price controls, and training programs for workers. An important instrument in governmental economic influence is the BUDGET.

Central Planning. Although fairly centralized national economic planning has appeared in the 20th century in some Western countries, such as France, Great Britain, and Sweden, the first country to adopt strict central planning was the Soviet Union, which in 1927 began to direct every major phase of economic activity—from setting overall goals to detailing prices and outputs of particular firms. For the next six decades the Soviet economy remained highly centralized. Prices set by state planners did not necessarily reflect the actual costs of production. Centralization required that enormous amounts of information be gathered and analyzed by the authorities in order to determine the targets for every industry and enterprise. Prices were often set at a level that limited demand to the amount of goods available. Unlike the free market system, under centralized planning, shortages and higher prices do not necessarily lead to an increased supply.

Beginning in the mid-1980s, the USSR decentralized economic planning and effected other reforms in order to accelerate the economy (see PERESTROIKA).

Among the less-developed countries, centralized planning has usually been a key element of economic growth. As in the early Communist model, the development strategy's central element is usually a comprehensive 5-year plan designed to alleviate production bottlenecks and provide for government-sponsored social programs.

economics Decades of controversy about the nature and appropriate boundaries of his discipline led the economist Jacob Viner to observe that "economics is what economists do." Somewhat more precisely, economists engage in systematic inquiry into the effects of those human activities which are grouped under three broad headings: production, exchange, and consumption. The nature and magnitude of these activities and their implications for individual and social welfare constitute the focus of economics and the policy prescriptions that economists make.

Basic Concepts

The basic objective of all economic activity is to achieve the highest possible level of present consumption of goods and services that is compatible with the supply of human and material resources (or factors) available to produce them. The scarcity of human and material resources, as evidenced by the existence of prices, imposes the necessity of allocating resources among alternative present and future uses (see PRICE SYSTEM). Choice, therefore, is the essence of economic decision making.

The choice process occurs both at the level of the household and at that of the business firm. Households that are free to exercise their choices in the marketplace are assumed to behave in a manner that will yield maximum satisfaction, or utility. The essence of rational behavior for a household is to spend its last (or marginal) unit of money income for that item or service which will provide the greatest possible utility. Such choices act as signals to businesses about consumers' preferences (see SUPPLY AND DEMAND).

Rational behavior in the business sector implies that firms direct their efforts toward maximizing profits. To do this they must, first, be responsive to the demands of the household sector for goods and services and, second, combine the labor and material resources they employ in such a way as to minimize their production costs. This is the essence of efficient production.

Inquiry into the nature and results of the choices that households and business firms make is the concern of microeconomic analysis, the focus of which is the behavior of the individuals, organizations, and institutions in the economy. Whereas all acts are, of course, individual acts, individuals frequently make decisions and act on behalf of some organization or institution, public or private.

The study of the behavior of households and business firms is only one part of economic analysis, however. The other part is concerned with the study of the behavior of economic aggregates—macroeconomics (see ECONOMY, NATIONAL). The results of economic performance can be measured in terms of production and income. Chief among the "yardsticks" that measure the economy's overall performance is GROSS NATIONAL PRODUCT, which aggregates the market value of all final goods and direct services produced during the year. Production costs (wages, rent, interest, depreciation, managerial profits, and taxes) that are incorporated into consumer prices constitute an income stream that corresponds to GNP—gross national income, which aggregates the income earned by the owners of the productive factors (labor, capital, and natural resources) used by business firms (see INCOME, NATIONAL).

The size of the GNP, and its income counterpart, reflects the level of employment, another important macroeconomic aggregate. The level of employment is dependent on aggregate effective demand, which consists of the consumption and investment (or capital goods) demands of households and businesses. Macroeconomic aggregates are thus critically linked to the microeconomic decisions made in the household and business sectors of the economy. A major concern of macroeconomics is the influence of the government and the CENTRAL BANK on aggregate demand through implementation of FISCAL POLICY and MONETARY POLICY, respectively.

History of Economic Thought

When economics first began to emerge as a separate discipline in the 18th century, its concern was chiefly with phenomena that are today classified as macroeconomic. In the three decades preceding the French Revolution the PHYSIOCRATS presented a plea for "revolution from above" through a monarch enlightened about the natural order in relation to the economic well-being of the economy. The physiocrats maintained that tax abuses, large public debts, foreign wars, court extravagances, and special stimuli for the production of luxury goods (tapestries, silks, velvets, porcelain) that were exported—in accordance with the principles of MERCANTILISM—to obtain gold progressively diminished the economy's well-being. In their view, the goods derived from land (and therefore "natural"), not gold, constitute wealth. The physiocrats, who were fond of referring to themselves as "the economists," constructed a theory of an ideally functioning economy that would tend automatically to achieve optimum results, but for the disturbances injected by human beings uneducated in the ways of the natural order. This rationale is the basis for the famous maxim *Laissez faire, laissez passer* ("Let it be, let it go"; see LAISSEZ-FAIRE).

The Scottish moral philosopher Adam SMITH, who intended his *Inquiry into the Nature and Causes of the Wealth of Nations* (1776) as a capstone to his work as a philosopher, commended the physiocrats not only for understanding the true nature of wealth, but also for recognizing the essential role of economic freedom in promoting its growth. The central theme of the *Wealth of Nations* is the growth of national wealth. Smith's focus, therefore, parallels that of the physiocrats. For Smith, however, it is not nature but human effort that makes commodities available. Smith believed that the natural trend of economic development is upward and that this trend is most likely to manifest itself within the framework of an "obvious and simple system of liberty," or perfect competition. The implication is that if businesses are free to seek out the best opportunities for maximizing gains, the most productive employments will be sought out first. Legitimate areas of government intervention exist, but ideally, the activities in which the state engages ought to be minimal because the labor of the sovereign and other governmental servants is "unproductive." The incomes they receive are transfers and do not generate wealth.

For the most part Smith expressed faith in the operation of the "invisible hand"—the marketplace operating according to supply and demand mechanisms—for bringing about a harmony of social interests in the still primarily agricultural economy of the late 18th century. The subsequent appearance of capital in the form of machinery, and the mechanization of industry that accompanied it, however, made questionable Smith's doctrine that the accumulation and employment of capital would automatically coincide with the advancing material progress of all classes of society.

Whereas Adam Smith had little concern with distinguishing between economics as a science and economics as a branch of politics, his French disciple Jean Baptiste SAY concentrated on the use of the deductive method to derive the laws that govern the production, distribution, and consumption of wealth. Say's method, and his arrangement of the subject matter of economics, has become classical. His teachings were introduced into England by James MILL, father of John Stuart Mill. It was the elder Mill who taught the deductive method of analysis to the British economist David RICARDO, whose work became the prototype for a whole school of thinkers who sought to discover universal laws of production, exchange, and distribution. The term *classical* is used in connection with their work to convey the virtually universal acceptance of their methodology and economic principles up to about 1870, and to distinguish their work from that of various dissenting schools.

During the 19th century, Continental philosophers challenged the doctrine of natural law that underlies the classical tradition of political economy. Georg Wilhelm Friedrich HEGEL developed a philosophy of history that maintained that the course of history reflects the gradual realization by human beings of their own nature. The course of their development can be understood by using a method of reasoning that Hegel called the dialectic: one phenomenon (a thesis) works against another (the antithesis) to produce something wholly new (the synthesis). Thus the feudal system (the thesis) of the Middle Ages encountered the force of the market system (the antithesis) of the mercantilistic era, and their inevitable clash produced an entirely new system, CAPITALISM (the synthesis).

Karl MARX came under the influence of Hegel's philosophy, which underlies Marx's objective, expressed in volume 1 of *Das Kapital*, "to lay bare the economic 'law of motion' of modern society." The prime mover of social change, he maintained, was to be found in changes in the mode of production. The mode of production is associated with the whole complex of social relationships that reflects the ownership and use of the material means of production. According to Marx, it is the contradiction that develops between the altered mode of production and existing social relationships that generates changes and conflicts in the relationships among social classes. Conflict between the ruling class and the exploited class is always present.

In a capitalistic economy, which Marx viewed as a transitory stage in the historical evolution of society, the antagonistic classes are the bourgeoisie and the proletariat. The essential feature of the mode of production under capitalism is that ownership of the means of production (that is, capital and land) is vested in the bourgeoisie, while the work is performed by the proletariat. The relationship between them determines the mode of production, and hence, the whole society. The only form of property that workers own is their labor power. Because the means of production needed to exploit the laborers' productive capabilities are owned by the capitalist class, workers have no choice but to sell their labor power to the capitalist class at the going competitive wage rate. The exchange relationship between the worker and the employer, however, requires the worker to labor the entire working day, which is typically longer than is needed for producing the worker's subsistence. Under capitalism the creation of surplus value is therefore inherent in the mode of production and is the source of the inevitable conflict between laborers and capitalists. Ultimately, the contradictions make the system untenable. Conditions are then ripe for the proletariat to seize the instruments of production and establish socialism, which is the first stage of full communism. This all-important transformation, in Marx's view, cannot come about without revolution (see MARXISM).

The powerful criticism that Marxism leveled against classical political economy summoned up the counterattack, in the late 19th century, of the marginalist school, which, in Britain, ultimately evolved into the neoclassical tradition.

Whereas the classical economists were concerned chiefly with the production side of the private-enterprise system, the neoclassicists articulated a supply-and-demand theory of values and a theory of distribution that explained the sharing of income among the productive factors—land, labor, capital, and enterprise. Thus the chief concern of neoclassical economics was with explaining those economic phenomena which are today categorized as microeconomic. There was little concern with macroeconomics because it was presumed that powerful market forces tend to ensure that the economy will work toward fully employing its labor and capital resources, so that none will be involuntarily idle.

This assumption was effectively challenged by John Maynard KEYNES in his important book *The General Theory of Employment, Interest and Money* (1936). His chief argument was that market forces, in the form of wage and interest-rate reductions, cannot be relied on to channel all workers seeking employment into jobs or all savings into investment. A full-employment equilibrium results only if the level of aggregate demand is sufficiently high to ensure that the employment of labor and the investment of savings are profitable (see SAVINGS AND INVESTMENT). This ideal situation is sometimes impeded by the dynamic nature of a modern capitalistic economy, which renders itself particularly vulnerable to uncertainty. When uncertainty reduces spending and investment, Keynes maintained that direct intervention by the government in the form of public works is sometimes necessary to restore full employment and aggregate demand.

The Post-Keynesian Era

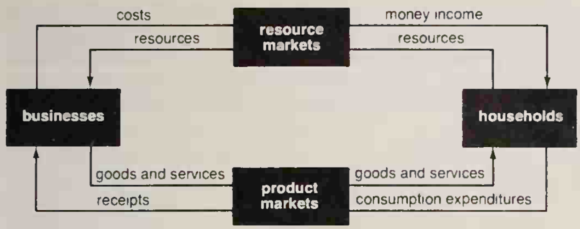
After the publication of Keynes's *General Theory*, efforts were made to reaffirm traditional neoclassical views. The most prominent branch of the neoclassical tradition is the monetarist school, whose leading representative is Milton FRIEDMAN. The monetarists reject Keynesian fiscal policy, supporting the use of monetary policy to encourage stable economic growth and restrain inflation.

Beginning in 1981 the administration of Ronald Reagan tried yet another approach, combining large cuts in federal spending with large tax cuts. Powered by deficit spending, the economy began a long upswing, but by the end of his term in 1989, Reagan left record federal deficits, and the United States had become a debtor nation.

See also: BANKING SYSTEMS; INTERNATIONAL TRADE; MONEY; MONOPOLY AND COMPETITION.

economy, national The term *national economy* describes the interrelationships among a country's levels of employment, production and consumption of goods and services, and prices. This article discusses those interrelationships in the context of the market economies of industrialized countries.

The Circular Flow of Income and Output. The functioning



of the national economy can be visualized in terms of a circular flow. The flow links households and businesses with the markets in which they buy and sell resources and products. Households, which are the ultimate owners of all the country's resources (land, labor, capital, and entrepreneurial talent), supply these resources in exchange for income payments (rent, interest, wages, and profits). In the business sector, resources are combined in various ways to produce a supply of goods and services. Consumers spend their incomes for these goods and services through a complex of product markets, and these consumer expenditures in turn become receipts or revenue to the business sector.

Economic Equilibrium. The level at which the national economy operates—that is, whether it functions at full employment or less than full employment—depends on the size and stability of these income and expenditure flows. For example, assume that the business sector produces that level of national output or quantity of goods and services at which all available resources are fully employed. This full-employment output can be sustained if the total flow of the spending is just sufficient to take that output off the market. If expenditures are deficient, businesses will find themselves with unsold output, and they will react by cutting back on production and employment. Similarly, if total expenditures exceed the current value of total output, the excess will give rise to inflation.

This circular flow assumes a self-contained, or closed, system in which income and expenditure flows are stable and repetitive. The real world, however, is more complex than this model suggests. In particular, the model must be adjusted for saving and investment. Households may not consume all their income; they may save a portion of it. Consequently, household consumption would seem to fall short of the national output. Some of the national output, however, is not available for household consumption; it is in the form of investment, or capital, goods (such as machinery and equipment or new factory construction), which businesses produce for one another and which must be added to the consumption spending of households to determine total or aggregate expenditures.

Whether the national output is stable ("in equilibrium") depends on whether saving by households is offset by investment spending by businesses. In other words, the critical question is whether investment spending will fill the "consumption gap" created by saving. If investment is precisely equal to saving, aggregate expenditures will be precisely equal to national output, and equilibrium will result. If saving exceeds investment, aggregate expenditures will fall short of national output, causing recession. If the economy, however, is at less than full employment initially and investment exceeds saving, the excess of aggregate expenditures will induce the business sector to expand national output and employment.

Stabilization Theory

One of the most important questions in industrial countries is whether saving can normally be expected to equal investment so that the economy will operate at full employment. The answer offered to this question by economists has varied historically. The classical economists of the 19th and early 20th centuries argued that the money market and the interest rate would normally cause saving and investment to balance each other. They reasoned that households would save (refrain from consumption) only if someone would pay them a rate of interest as a reward for their thriftiness. Furthermore, the amount saved would vary directly with the interest rate and thus provide a supply of loanable funds in the money market. The borrowers of these would be primarily businesses needing money capital to replace or enlarge their plants and their machinery and equipment. Because interest payments are a cost of borrowing as viewed by businesspersons, the amounts they would be willing to borrow and invest would vary inversely with the interest rate. In short, the money market was envisioned as the mechanism that would equate the supply of funds with the demand for funds.

Keynesian Theory. Contemporary Keynesian economists—deriving their basic ideas from the work of the British economist John Maynard Keynes—have argued that saving and investment may not necessarily balance and that therefore episodes of recession or inflation may occur. Keynesians maintain that savers and investors do not make their decisions on the basis of the interest rate; rather, saving depends primarily on income levels and varies directly with the level of income. Moreover, the main factor determining investment is its expected profitability.

Keynesians also contend that the traditional conception of the money market is too simple. The supply of funds in the money market is not comprised solely of current saving, but may also include funds provided by commercial bank lending or by the release of idle money balances held by the public. The result is that investment may exceed saving. Conversely, investment may be less than current saving if households use a part of saving to augment their idle money balances or to pay off debts.

Government Stabilization Policy. Keynesian economists therefore believe that the government should play an active part in attempting to stabilize the economy. In particular they advocate the use of fiscal and monetary policies in the hope of adjusting aggregate expenditures to the level of full employment without inflation.

Fiscal policy entails the adjustment of government spending and tax collections for the purpose of influencing the level of aggregate expenditures. If aggregate expenditures are deficient, the Keynesians recommend that government spending be increased and taxes reduced to stimulate household consumption and business invest-

AT A GLANCE

REPUBLIC OF ECUADOR

Land: Area: 283,561 km^2 (109,483 mi^2). Capital: Quito (1989 est. pop., 1,233,865). Largest city: Guayaquil (1989 est. pop., 1,699,375).

People: Population (1990 est.): 10,506,668. Density: 37 persons per km^2 (96 per mi^2). Distribution (1989 est.): 54% urban, 46% rural. Official language: Spanish. Major religion: Roman Catholicism.

Government: Type: republic. Legislature: National Congress. Political subdivisions: 21 provinces.

Economy: GDP (1989 est.): $9.8 billion; $935 per capita. Labor distribution (1987): agriculture—35%; government and services—24%; manufacturing—11%; commerce—11%; construction—7%. Foreign trade: imports—$1.7 billion (1988); exports—$2.2 billion (1988). Currency: 1 sucre = 100 centavos.

Education and Health: Literacy (1985): 84% of adult population. Universities (1988): 16. Hospital beds (1984): 15,455. Physicians (1984) 11,000. Life expectancy (1990): women—68; men—64. Infant mortality (1990): 61 per 1,000 live births.

ment spending. The resulting increase in aggregate expenditures will move the level of economic activity toward full employment. Conversely, if aggregate expenditures are excessive, government spending should be reduced and taxes increased. The consequent decline in aggregate expenditures will tend to ameliorate or eliminate the inflation.

Monetary policy concerns manipulating the money supply to change the interest rate and influence the investment component of aggregate expenditures. During a recession the money supply would be increased in order to lower interest rates and thereby induce businesses to borrow and invest larger amounts. During inflation the money supply would be restrained to increase interest rates and discourage investment. "Monetarists," represented by Milton Friedman, emphasize monetary policy over fiscal policy, although they argue for restraint in government intervention.

See also: ECONOMICS.

ecosystem see ECOLOGY

Ectocarpus [ek-toh-kar'-puhs] *Ectocarpus* is a genus of brown algae that appear as brown tufts of seaweed attached to rocks. These algae belong to the order Ectocarpales, division Phaeophyta. Distributed worldwide, they reach their best development in cold marine waters. The thallus (plant body) is small and has numerous branching filaments. The ectocarpus, like other brown algae, has a complex life cycle in which alternation of generations occurs. Environmental factors may influence which generation, if any, dominates a particular region of the world.

Ecuador Ecuador is a republic on the northern Pacific coast of South America bordered on the north by Colombia and on the south and east by Peru. It also includes the Galápagos Islands off the Pacific Coast. Ecuador was a Spanish colony until 1822. Today it is the South American nation where traditional society remains most nearly intact. Since the discovery of petroleum, however, Ecuador's developing economy is bringing increasing modernization to the nation.

Land

Ecuador is divided into three distinct physical areas, which also differ culturally and politically. The coastal region, or *costa*, has a tropical climate with an average temperature of 24° C (75° F). Centering on the port city of Guayaquil, the region contains about 50% of the country's total population. Most of Ecuador's tropical export products are grown here. The second area is the mountain region—the high Andes, or *sierra*—centering on the capital city of Quito, which lies 2,803 m (9,222 ft) above sea level. The climate here is temperate, moderated by the elevation, with an annual average temperature of 19° C (66° F). The region is subject to occasional, severe earthquakes. The region's agriculture produces mainly grain and meat for domestic consumption.

Finally, there is the eastern area, or *oriente,* which is part of the Amazon Valley and constitutes about half the country's area. It is inhabited principally by Indians. The wet climate supports a dense tropical rain forest, and the average temperature is 25° C (77° F).

People

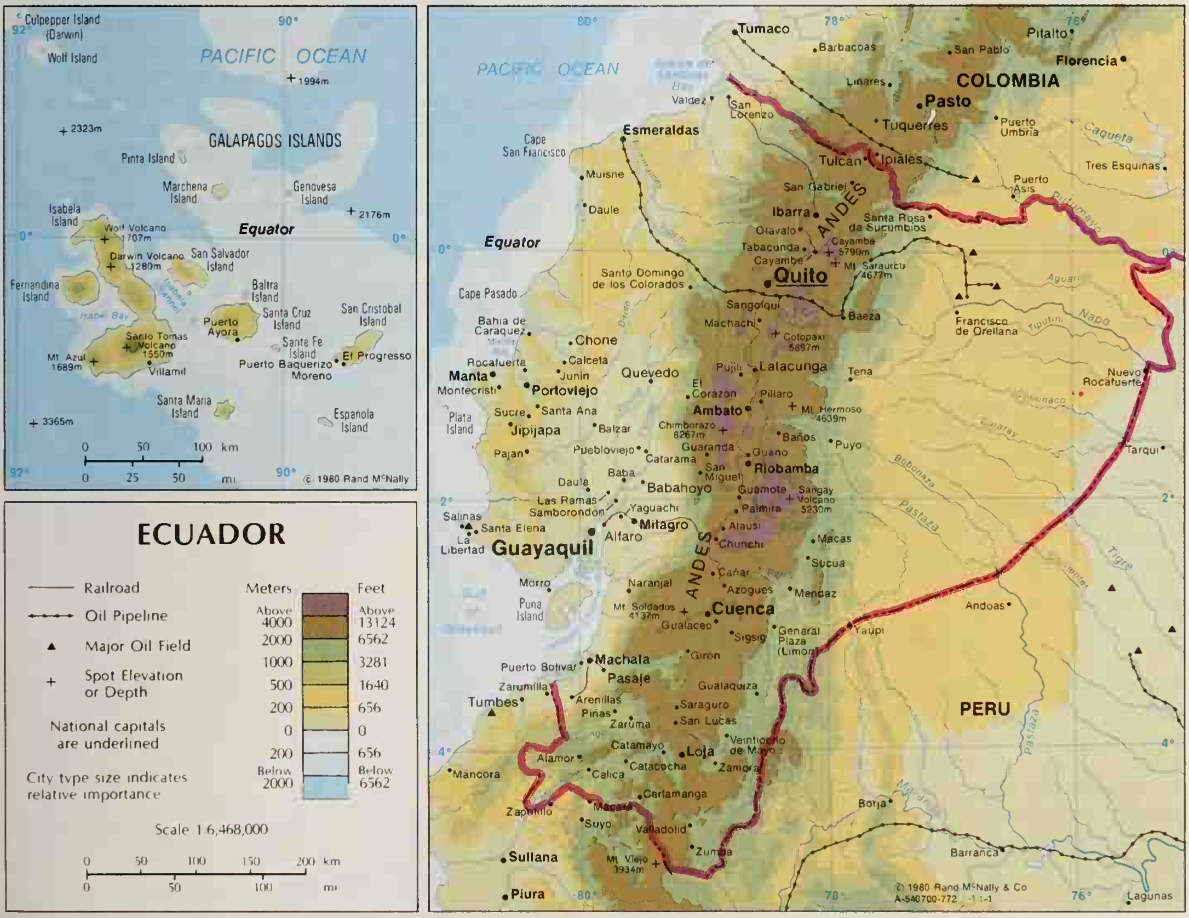
The population of Ecuador is ethnically and racially mixed. About 40% of the population is mestizo (of mixed Indian and European ancestry) and another 40% is Indian. The remainder of the population is about equally divided between Europeans (whites) and Negroes or mulattoes. The *costa* has the most heterogeneous population, whereas the population of the *oriente* is almost entirely Indian. Spanish is the official language and is spoken by most of the population. Several Indian languages, including Quechua, are also spoken. About 95% of the population is Roman Catholic.

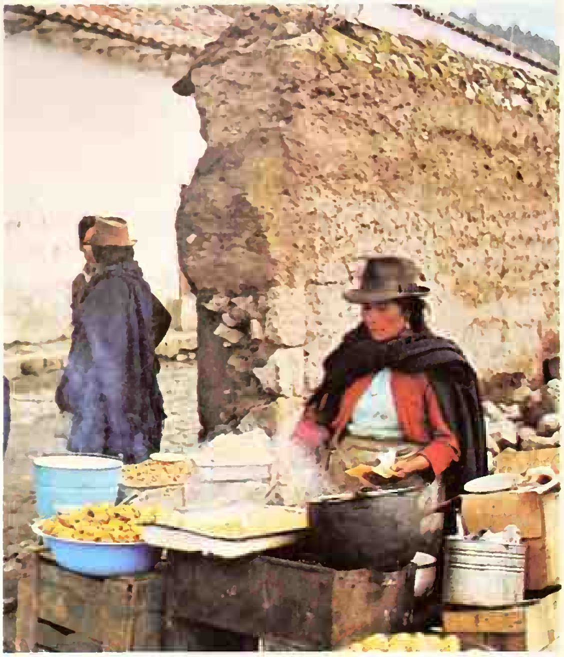
Education is compulsory for children between the ages of 6 and 14, with both free public schools and private parochial schools playing a significant role in education. In the late 1970s and into the 1980s literacy made great gains.

Economic Activity

About a third of the labor force are still involved in agriculture. In the mountain areas the peasants continue to work in semiserfdom on many large haciendas (estates established during the Spanish period). Grain growing and livestock raising are the principal activities. Along the coast, plantations have developed that grow cacao, a traditional export; sugar, used largely for internal consumption; rice; coffee; and bananas. The seafood sector, too, has shown rapid expansion.

Ecuador has also experienced the beginnings of an industrial revolution. In the urban centers, especially CUENCA, Quito, and Guayaquil, textiles, shoes, foodstuffs, and other manufactured goods are produced for the internal market. Plants also process agricultural products for export.





This Indian woman sells filled tortillas in a local marketplace in Ecuador. Indians constitute an estimated 40% of Ecuador's population, with the majority of them living in the mountainous Sierra region.

During the 1970s, petroleum became an important part of the Ecuadorean economy. Resources in the eastern part of the country were largely developed by U.S. corporations, and a pipeline was built to facilitate oil shipment abroad. In 1977 the government agreed to buy out the U.S. interests, and the first refinery opened. The discovery of petroleum resulted in a rapid and striking increase in the country's national income; Ecuador became the third largest petroleum exporter in Latin America (after Mexico and Venezuela). With falling oil prices in the mid-1980s, however, Ecuador's economic problems proliferated—it missed payments on its foreign debt and instituted an austerity program, sparking protests. Earthquakes and floods in 1987 killed hundreds and damaged the main oil pipeline, which was nationalized in 1989.

History and Government

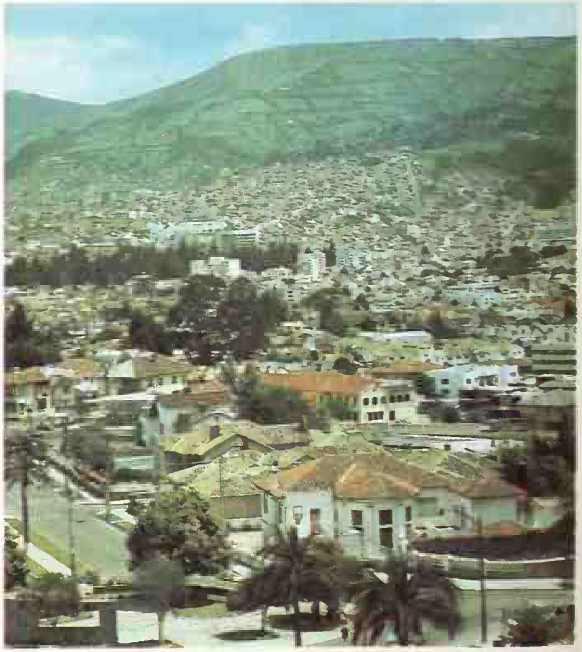
Ecuador was part of the Inca empire at the time of the Spanish conquest in the 1530s. The last Inca king, Atahualpa, was of part Ecuadorean origin. Under the Spaniards, Ecuador belonged to the viceroyalty of Peru until 1739, when it became part of the new viceroyalty of New Granada.

Immediately after liberation in 1822, Ecuador was a province of the new republic of Gran Colombia (consisting of the present-day nations of Colombia, Ecuador, Panama, and Venezuela), of which Simón Bolívar was president. With the dissolution of the federation in 1830, Ecuador became an independent republic. During most of the 19th century, it was dominated by a series of caudillos (dictators), including Gabriel García Moreno, who dominated national politics between 1860 and 1875. Eloy Alfaro (1864–1912) led the Liberal Revolution of 1895, which carried out anticlerical reforms and stressed economic expansion; Alfaro was assassinated, but the Liberals remained powerful until 1944.

During the 20th century, commercial agriculture has expanded along the coast, and there has been a concomitant increase in the political power of that part of the country. The nature of national politics has not varied substantially, however. Military regimes have tended to alternate with civilian governments chosen by an electorate limited to the literate. There were 14 presidents between 1931 and 1940, and this political instability abated only briefly in the late 1940s and the 1950s. The outstanding civilian leader during these decades was José María Velasco Ibarra.

Through all these political changes, the social and economic system has altered little. In the Andean valleys and plateaus, large landowners continue to maintain control. A modest manufacturing sector has grown up, but until the advent of the oil industry, Ecuador's economy remained agricultural. Military regimes in the 1960s and '70s made tentative efforts to launch land redistribution programs, but the results were modest. In 1979 the ruling junta permitted national elections for the first time in 11 years, and under a new constitution a civilian government was elected. Due to the oil slump, mounting foreign debt, and the 1987 earthquake damage, presidents León

Quito, the capital of Ecuador, occupies a volcanic basin in the foothills of the Andes. The city is situated only 18 km (11 mi) south of the equator, from which the nation's name is derived.



Febres Cordero (elected 1984) and Rodrigo Borja Cevallos (elected 1988) were faced with a severely stressed economy. The latter instituted a strict austerity program and succeeded in reducing inflation and restoring foreign reserves.

ecumenical council see COUNCIL, ECUMENICAL

ecumenical movement *Ecumenical movement* is the term used to describe the search for fuller unity that has been a notable feature of the life and work of Christian churches in the 20th century. The Greek word *oikumene,* from which ecumenical is derived, originally meant "the inhabited world." There were ecumenical COUNCILS in the early centuries of the church; they were called ecumenical because they represented the whole church.

The movement toward greater unity among Protestant churches received its primary impulse from the modern missionary movement. A world conference on Christian MISSIONS held in Edinburgh in 1910 gave the impetus to ecumenical concern and resulted in the creation of ecumenical organizations that later combined to form the WORLD COUNCIL OF CHURCHES. The Roman Catholic church remained aloof from these developments until the pontificate of JOHN XXIII. He created the Secretariat for Promoting Christian Unity and convened the Second VATICAN COUNCIL (1962–65).

The ecumenical movement has many expressions: the NATIONAL COUNCIL OF CHURCHES in the United States; the World Council of Churches and the Vatican Secretariat for Christian Unity; and the continuing activity of nonecclesiastical bodies like the YMCA, the YWCA, and BIBLE SOCIETIES.

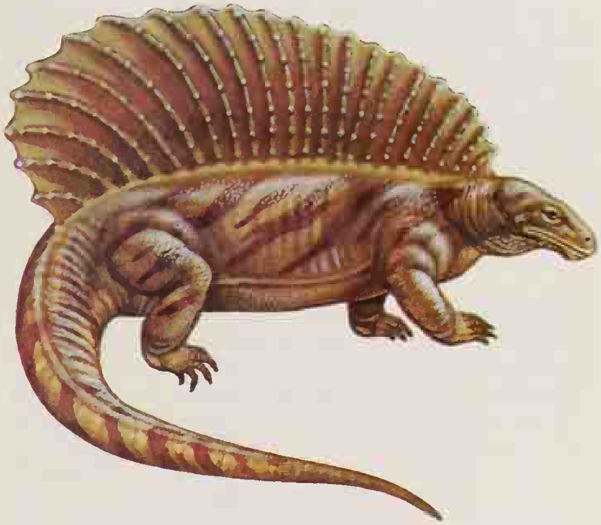
eczema [ek'-sim-uh] Eczema, or atopic DERMATITIS, a symptom of various skin disorders, is characterized by noncontagious, itching skin on which scaly, red patches and tiny, fluid-filled blisters may appear. When the blisters burst, the skin "weeps." The ailment occurs mainly on the ears, hands, feet, and legs. In infants, it is often caused by allergy to certain proteins. Emotional problems and mental stress are suspected of causing eczema in adults. Heredity also seems to be involved.

Eczema is best treated by finding and removing the cause. Lukewarm compresses help relieve the itching and redness of weeping skin. Once the skin is dry, it may be treated with cortisone or X-ray therapy. Scratching should be avoided at all times. Normally, eczema clears up on its own.

See also: skin diseases.

Edam [ay-dahm'] Edam (1984 est. pop., 24,019) is a city in North Holland province in the western Netherlands about 19 km (12 mi) northeast of Amsterdam. The town, linked by canal to the IJsselmeer, includes Volendam, a fishing village and popular resort. Edam is best known as a market for Edam cheese, ball-shaped and encased in red wax, which is made in the surrounding area. The town of Edam, chartered in 1357, was an important seaport and shipbuilding center from the 14th to 16th centuries, but flood control and reclamation projects caused its harbor to silt up. The town has a fine 14th-century church, rebuilt in the 17th century.

Edaphosaurus [ed-uh-fuh-sor'-uhs] One of the pelycosaurs, primitive mammallike reptiles of the Late Carboniferous and Permian periods (see GEOLOGIC TIME), *Edaphosaurus* was a small to medium-sized herbivore with a low, bulky body, short, sprawling legs, and a long, heavy tail. It may have weighed as much as 180 kg (400 lb). Its most distinctive feature, a high rigid dorsal fin stretching from the back of its head to behind its hips, was supported by long spines from the backbone and had many lateral projections, or crossbars. It has been theorized that the dorsal fin functioned as a temperature-regulating device (see DIMETRODON), but perhaps the fin merely made the animal appear much larger, in side view, to potential predators.



The Edaphosaurus, *a plant-eating reptile predating the dinosaurs, bears a resemblance to the sailbacked* Dimetrodon, *a carnivore.*

EDB The chemical compound ethylene dibromide (EDB) aroused great controversy in the early 1980s that led the U.S. Environmental Protection Agency (EPA) to ban its use as an agricultural pesticide. Since 1948, EDB had been used to fumigate soils for grain cultivation and to protect citrus and other fruits against the transport of fruit flies. In 1975 the National Cancer Institute reported EDB to be highly carcinogenic and a cause of reproductive disorders in laboratory animals. Although the effects of EDB on humans could not be subject to such analysis, the chemical became a subject of increasing concern to environmental groups and to workers who had to handle EDB. The issue was accelerated in 1980, when the EPA approved the use of EDB in soybean cultivation. Subsequent tests of water resources in a number of states revealed high levels of the chemical. In 1983 the EPA banned the use of EDB as a soil fumigant; in 1984 the ban was extended to fruit crops.

The primary use of EDB, however, has been as an additive to leaded gasolines, in order to inhibit the formation of lead deposits. The chemical is present in very low concentrations and is not considered to add significantly to the environmental hazards the fuels already present, particularly as they are being replaced by unleaded gasolines.

Edda [ed'-uh] Two collections of Old Norse writings are known by the title of Edda; together they form the most authoritative source for ancient Nordic mythology. The *Elder*, or *Poetic, Edda* is a collection of 34 Icelandic poems, interspersed with prose, dating from the 9th to the 12th century. These anonymous poems use alliteration and a simple strophic form as their only formal devices. Most of them deal with Norse mythology and legend.

The *Younger*, or *Prose, Edda* (*c.*1220) is the work of the Icelandic poet and historian SNORRI STURLUSON. It was probably intended as a handbook for novice poets who wished to become *skalds*, creators of the sophisticated poetry recited in court. The *Prose Edda* contains a preface on the creation of the world; mythological stories; sayings attributed to the Norse god of poetry, Bragi; rules governing prosody; and an analysis of ancient poets.

See also: Icelandic literature; Norse mythology in MYTHOLOGY; NIBELUNGENLEID; SKALDIC LITERATURE.

Eddington, Sir Arthur A pioneer in the field of stellar structure and an avid researcher in cosmology and relativity theory, the English astronomer Arthur Stanley Eddington, b. Dec. 28, 1882, d. Nov. 22, 1944, was also well known for his sparkling literary style, which made astronomy a living science for his many readers. Extending the work of Karl Schwarzschild in Germany, Eddington concluded that a star was held together by virtue of the balance of the forces of gravity, gas pressure, and radiation pressure. This landmark research, along with his enunciation of the stellar mass-luminosity relation, his determination of the density of white dwarf stars, and his queries into the sources of stellar energy were treated in his classic work *The Internal Constitution of the Stars* (1926).

Eddington was among the first to understand the revolutionary implications of Einstein's theory of general relativity. He organized the 1919 ECLIPSE expedition, which confirmed the prediction of the relativistic bending of light in a strong gravitational field.

Eddy, Mary Baker Mary Baker Eddy, b. Bow, N.H., July 16, 1821, d. Dec. 3, 1910, was an American religious leader and the founder of CHRISTIAN SCIENCE. During her early adult years she suffered increasing invalidism. In 1866, after sustaining a severe injury through a fall, she read a Gospel account of one of Jesus' healings. She believed that she had an insight into the method by which Jesus Christ healed; at that moment she felt herself restored to health.

The American religious leader Mary Baker Eddy founded (1879) the Church of Christ, Scientist, based on the metaphysical theories of healing and scriptural interpretation that she developed. Her book Science and Health with Key to the Scriptures *(1875) is the official text of Christian Science.*

She made an intensive study of the Bible for 3 years after her cure and came to the belief that she was able not only to heal the sick herself but also to teach others to heal as well. She held that all sickness was mental rather than physical and recorded the laws of God as she had discerned them in *Science and Health with Key to the Scriptures* (1875). This book contains a full statement of what she called Christian Science.

In 1877 she married Asa Gilbert Eddy, an active Christian Scientist. Two years later Mrs. Eddy founded the Church of Christ, Scientist, whose organization she oversaw closely. She also established (1908) the *Christian Science Monitor*.

Eddy, Nelson, and MacDonald, Jeanette Nelson Eddy, baritone, and Jeanette MacDonald, soprano, were popular stars of movie musicals in the 1930s and '40s. They appeared together in eight films from 1935 to 1942. Eddy, b. Providence, R.I., June 29, 1901, d. Mar. 6, 1967, made his opera debut (1924) with the Philadelphia Civic Opera. His performances brought him to the attention of Hollywood filmmakers, and he arrived there in 1933. MacDonald, b. Philadelphia, June 18, 1907, d. Jan. 14, 1965, achieved stardom in the 1920s in Broadway musicals, appearing in her first movie in 1929. She teamed with Eddy in *Naughty Marietta* (1935), which was their first film together; *I Married An Angel* (1942) was their last. Their other well-known films include *Rose Marie* (1936) and *Maytime* (1937).

edelweiss [ay'-dul-vys] Edelweiss, *Leontopodium alpinum*, is a perennial herb in the family Compositae. Native to the mountains of Europe and Asia, it has narrow woolly leaves and erect stems up to 30 cm (12 in) high. The apparent flowers of the edelweiss are actually the whitish bracts, or reduced leaves, that surround the true, inconspicuous flowers.

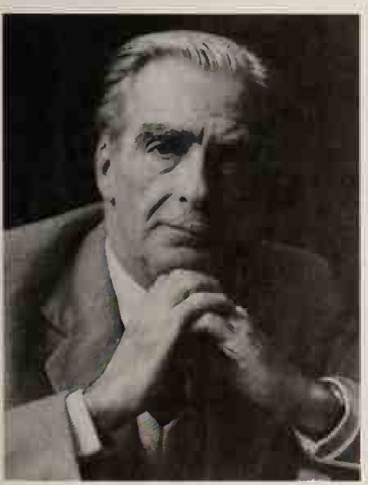
edema [ed-ee'-muh] Edema is swelling caused by an excessive accumulation of fluid in body tissues and cavities. Also called dropsy, or preferably hydrops, edema is symptomatic of a wide range of conditions and disorders, including heart and kidney disease. These disorders must be addressed, but relief from edema itself may be provided by DIURETIC DRUGS, which stimulate the kidneys to eliminate water from the body.

Eden, Sir Anthony The British statesman Sir Anthony Eden, b. June 12, 1897, d. Jan. 14, 1977, held the office of foreign secretary three times and was prime minister from 1955 to 1957.

Robert Anthony Eden entered the House of Commons as a Conservative in 1923. Foreign secretary from December 1935, he resigned in 1938 because he disagreed with Neville CHAMBERLAIN's policies, but returned to that office under Sir Winston CHURCHILL late in 1940 and served throughout World War II. During Churchill's 1951–55 government, Eden was again foreign secretary.

When he succeeded Churchill as prime minister in 1955, Eden called a general election, which the Conservatives won with a majority larger than that of 1951. He soon encountered difficulties, however. When Egyptian president Gamal Abdel NASSER nationalized the Suez Canal in July 1956, Eden and the cabinet determined that Egypt must be convinced to keep the canal open. The Anglo-French attack on Egypt in October and November 1956 produced violent controversy. Eden's precarious health broke down during this SUEZ CRISIS, and he resigned in January 1957.

Eden lacked the opportunity to prove himself as prime minister, but he is remembered for his strong sense of international community and his excellence as a negotiator. He was made earl of Avon in 1961.



Sir Anthony Eden, a British statesman and diplomat, was foreign secretary three times before succeeding Sir Winston Churchill as prime minister in 1955. An able negotiator, Eden chaired the 1954 Geneva Conference on Indochina. His premiership was marred by the controversial Suez Crisis of 1956.

Eden, Garden of In the Bible the Garden of Eden was the original home of ADAM and EVE. It was a well-watered garden with beautiful trees. Also called Paradise, Eden symbolized the unbroken harmony between God and humankind before the first sin, after which, according to Genesis 3, Adam and Eve were expelled from the garden.

edentates Edentata is an order of placental mammals comprising about 30 species. Ground SLOTHS and glyptodonts (animals resembling ARMADILLOS) are among the eight extinct families of edentates. Although edentata means "without teeth," all edentates except for the true ANTEATERS have teeth. The other two major groups—tree sloths and armadillos—have peglike, continuously growing cheek teeth that lack enamel. Edentates have evolved only in the Americas, and most living species inhabit South America. The length of the body (including the head) ranges from less than 15 cm (6 in) for the pink fairy armadillo (genus *Chlamyphorus*) to about 1.8 m (6 ft) for the giant anteater (*Myrmecophaga*). The giant armadillo (*Priodontes*) is the heaviest edentate, at 60 kg (132 lb), and the pink fairy is the lightest, at 98 gm (3.5 oz).

Tree sloths, which eat plants, have powerful limbs and long, curved claws that enable them to hang from tree limbs. Armadillos, which have a flexible armor on their upper side, eat insects, small vertebrates, carrion, and plants. Anteaters use powerful front claws to uncover ants, termites, and beetle larvae, capturing the insects on their sticky tongue.

Ederle, Gertrude [ay'-dur-lee] Gertrude Caroline Ederle, b. New York City, Oct. 23, 1906, was the first woman to swim (1926) the English Channel. Ederle began swimming competitively at 13 and won a distance swim the following year. As a teenager she won several U.S. national championships for short freestyle events and two bronze medals and a gold in the 1924 Olympic Games; she also set world records in the 100-, 200-, and 400-meter events. Turning professional in 1925, Ederle not only swam the Channel the following year but did it in a record time (by man or woman) of 14 hours, 31 minutes from France to England.

Edgar, King of England Edgar, b. 943, d. July 8, 975, was king of the English from 959. A younger son of King Edmund of WESSEX, he became king of Mercia and Northumbria on the deposition (957) of his brother, Edwy, whom he also succeeded as king of Wessex (959). Edgar appointed Saint Dunstan (924–88) archbishop of Canterbury and supported his monastic reforms. In 973, Dunstan crowned Edgar in a ceremony that emphasized the close ties between king and church. Later, Edgar also received homage from seven Welsh and Scottish kings.

Edgerton, Harold Eugene The American scientist Harold Eugene Edgerton, b. Fremont, Nebr., Apr. 6, 1903, d. Jan. 4, 1990, perfected (1931) the modern STROBOSCOPE, a device capable of emitting flashes of light as short as 1/1,000,000 of a second as often as 100 times per second. In addition to its many scientific applications, it can produce photographs that arrest the flight of a bullet or analyze the successive stages of a golf swing. A series of such pictures made by Edgerton in the 1930s is considered beautiful enough to serve art as well as science. Edgerton also applied his invention to underwater studies.

Edgeworth, Maria The Irish novelist Maria Edgeworth, b. Jan. 1, 1767, d. May 22, 1849, influenced Sir Walter Scott and Jane Austen with her novels of regional life and customs. The best known of these include *Castle Rackrent* (1800), *Belinda* (1801), and *The Absentee* (1812). She also wrote moral stories for young people and an argument for women's education, *Letters to Literary Ladies* (1795).

Ediacaran fauna The Ediacaran fauna is an assemblage of multicellular fossils of the late Precambrian (see GEOLOGIC TIME). The fossils were first discovered in rocks of the Ediacara hills of South Australia but have since been found throughout the world. Some of these soft-bodied, shallow-water marine animals floated freely, whereas others appear to have crawled on or been attached to the sea bottom. They ranged up to 1 m (about 3 ft) in length.

Paleontologists regard the fauna, which flourished 700 to 570 million years ago, as evidence of a much more complex level of EVOLUTION than had previously been attributed to Precambrian time. When the fossils were first discovered and classified, the Ediacaran fauna were regarded as forerunners of phyla that appeared in the succeeding Paleozoic Era. A growing number of paleontologists now believe instead that the fauna were an evolutionary dead end. If this is true, the disappearance of the animals represents the first recorded mass EXTINCTION of geologic time.

Edinburgh [ed'-in-bur-uh] Edinburgh is the capital and the second largest city in Scotland, with a population of 433,500 (1988 est.) after Glasgow. It lies close to the southern shore of the Firth of Forth and is served by the port of Leith.

Edinburgh's site is marked by isolated hills, some of them volcanic, over and around which the city has spread. These include Arthur's Seat (251 m/823 ft) and Castle Rock, below which the old city with its narrow streets clustered. North of the rock lies the regularly planned 18th-century new city. Industrial development is primarily concentrated at Leith to the north. Edinburgh is, first and foremost, a cultural and educational center. Edinburgh University, the largest in Scotland, was founded in 1583 as Tounis (Town's) College and early became a famous center for medical studies. It was Britain's first urban university and served as the model for the University of London. The city is also noted for its schools, galleries, and museums, and it has an important annual festival of music and drama. Its architectural monuments include the castle, the Gothic St. Giles' church, Holyrood Palace, and many Georgian town houses.

Edinburgh Castle dominates the skyline above the Princes Street Gardens in Scotland's capital. Princes Street is Edinburgh's principal shopping street. The castle dates to the 11th century.

The name *Edinburgh* derives from the Celtic *Dune-eideann*, meaning "Eidin's Fort." The town grew up in the 12th century beneath the castle constructed on Castle Rock by Malcolm III (r. 1058–93). It suffered in the wars with the English but became the Scottish capital in the 15th century. Edinburgh lost importance in 1603, when the Scottish and English crowns were united and the seat of government was moved to London. Its cultural preeminence emerged in the 18th century, when the new city was built, and Edinburgh became one of the intellectual centers of Europe.

Edinburgh, Philip Mountbatten, Duke of Prince Philip, b. Corfu, Greece, June 10, 1921, is the consort of Queen ELIZABETH II of England. The son of Prince Andrew and Princess Alice of Greece, he is descended, through his mother, from the German family of Battenberg (which changed its name to Mountbatten in Britain). He is also a grandson of George I of Greece, great-grandson of Christian IX of Denmark, and great-great-grandson of Queen Victoria of England. Before his marriage to Princess Elizabeth on Nov. 20, 1947, Philip became a British subject and was created duke of Edinburgh. Since February 1952, when Elizabeth ascended the throne, Philip has accompanied her on many tours, often speaking openly on public issues. Elizabeth made him a prince of the United Kingdom in 1957.

Edirne [eh-deer'-neh] Edirne, also called Adrianople, is a city in European Turkey and the capital of Edirne province. It lies across the Maritsa River from Greece about 16 km (10 mi) south of Bulgaria. It has a population of 78,610 (1985) and serves as a regional market center where cheese, wine, textiles, leather, soap, and perfume are produced. Landmarks include the Selim (1574) and Bayezid (1488) mosques. Settled a few hundred years before the time of Christ, Edirne was rebuilt about AD 125 by the Roman emperor Hadrian, who named it Hadrianopolis (Adrianople). In 378 the Romans under Emperor Valens were defeated by the Goths at the Battle of Adrianople. From 1362 to 1453 the city was the capital of the Ottoman Empire.

Edison, Thomas Alva Thomas Alva Edison, b. Milan, Ohio, Feb. 11, 1847, d. Oct. 18, 1931, was one of the most prolific inventors of the late 19th century. He is most famous for his development of the first commercially practical incandescent lamp (1879). Perhaps his greatest contribution, however, was the development (1882) of the world's first central-electric-light-power station.

When Edison was 7 years old his family moved to Port Huron, Mich., where his formal schooling was limited to 3 months. Thereafter, his mother tutored him, and he developed into an avid reader. At age 12 he became a trainboy, selling magazines and candy on the Grand Trunk Railroad.

A station agent taught him telegraph code and procedures, and at age 15 Edison became manager of a telegraph office. His first inventions were the transmitter and receiver for the automatic telegraph. At 21, Edison produced his first major invention, a stock ticker for printing stock-exchange quotations in brokers' offices. With the $40,000 he was paid for improvements in tickers, he established a laboratory in Menlo Park, N.J., where he directed groups of employees working on various projects.

In 1878, Edison began work on an electric lamp and sought a material that could be electrically heated to incandescence in a vacuum. At first he used platinum wire in glass bulbs at 10 volts. He realized, however, that independent lamp control would be necessary for home and office use, so he developed a three-wire system with a supply of 220 volts and each lamp operating at 110 volts. The higher voltage required a resistance greater than that of platinum, so Edison conducted an extensive search for another filament material. On Oct. 21, 1879, he demonstrated a lamp containing a carbonized cotton thread that glowed for 40 hours.

Edison installed the first large central power station on Pearl Street in New York City in 1882. Its success led to the construction of other central stations. Edison founded The Edison Electric Light Company (1878), which eventually became part of the General Electric Company (1892).

While working on incandescent bulbs, Edison noted a flow of electricity from a hot filament across a vacuum to a metal wire. This phenomenon, known as THERMIONIC EMISSION, or the Edison effect, was the foundation of ELECTRONICS.

Edison also invented (1877) the PHONOGRAPH, the invention he was most proud of. His introduction of flexible celluloid film and his invention of the movie projector aided the development of motion pictures (see FILM, HISTORY OF). By the time he died in West Orange, N.J., he had patented over 1,000 inventions.

Edison is shown here after working five days and nights to perfect the phonograph. The phonograph is often called Edison's most original invention.

Edmonton Edmonton is the capital and principal city of Alberta, Canada. Occupying both banks of the North Saskatchewan River in the center of the province, it is Canada's sixth largest city and has a population of 573,982 (1986). Gateway to the important lumber, farming, and mining region to the north, Edmonton is a leading manufacturer of agricultural and petrochemical products and an important refiner. It is the originating point of several oil and natural-gas pipelines and is served by three railroad lines. One of Canada's largest meat-processing plants is located there. Wealthy, modern, and growing swiftly, Edmonton is a cultural center with the Edmonton Art Gallery (1969), a symphony, and opera and ballet companies. It is also the site of the University of Alberta (1906).

The Hudson's Bay Company established (1794) the fur-trading post of Fort Edmonton, and a village later developed. Expanding with the arrival of the railroad (1891) and the Klondike gold rush (1898), Edmonton was named capital of the newly created Alberta Province in 1905.

Edmund, Saint Saint Edmund, b. *c.*840, d. Nov. 20, 870, was king of East Anglia (855–70) and a martyr of the early English church. According to tradition, he was shot to death with arrows at Hoxne when he refused to divide his kingdom with a pagan Danish leader who had defeated him in battle. His shrine at Bury St. Edmunds became a pilgrimage site. Feast day: Nov. 20.

Edmunds, George Franklin George Franklin Edmunds, b. near Richmond, Vt., Feb. 1, 1828, d. Feb. 27, 1919, was a distinguished American constitutional lawyer and statesman. He served in both houses of the Vermont legislature and, from 1866 to 1891, in the U.S. Senate. Edmunds chaired the committee that determined procedures for the impeachment of President Andrew Johnson, wrote the bill providing for appointment of an electoral commission to decide the disputed 1876 presidential election, and authored the Edmunds Act (1882), which called for suppression of polygamy in the territories. He also wrote the greater portion of the Sherman Antitrust Act of 1890.

Edo [eh'-doh] The Edo, or Bini, are a people of southern Nigeria who live in villages and in the city of Benin, capital of a once-powerful empire founded in the 12th century by a prince from the YORUBA kingdom of IFE (see also: BENIN, KINGDOM OF). Over several centuries the Edo conquered and subjugated many other peoples. The *oba,* or king, was a sacred figure, had a large harem, and concerned himself largely with matters of state. Workers specialized in numerous crafts, especially metalwork, working directly for the *oba.*

The Edo speak a Kwa language of the Niger-Congo stock and number over 500,000. They grow cacao, oil palms, and rubber for cash crops. Trade is large-scale and complex. Descent and inheritance are traced through the father's line, and marriage is polygynous. Formerly, the men were divided into age grades, each group being assigned duties toward the community.

Edom [ee'-duhm] Edom was the land to the south and east of ancient Israel. Biblical tradition traces the Edomites to the patriarch Jacob's elder brother ESAU. Even though the Israelites had a racial tie with the Edomites, their relationship was one of constant hostility. No Edomite sources have survived, but archaeological evidence and other sources suggest a flourishing civilization of trade and agriculture in the second millennium BC.

education Throughout history societies have sought to educate their people to produce goods and services, to respond effectively and creatively to their world, and to satisfy their curiosity and aesthetic impulses. To achieve any of these objectives people need to acquire reliable knowledge and to think systematically. This article discusses the history of education in its general sense. Information on specific kinds of education and on education in particular parts of the world is provided in numerous separate articles, as, for example, ADULT EDUCATION and BRITISH EDUCATION.

Education has appeared in many shapes, both formal and informal. Major thinkers have always recognized the educational value of intellectual exploration and of concrete experimentation. Most societies have attempted to standardize the behavior of their members. To this end, they have used rituals to initiate the young into adulthood. Most societies have also had apprenticeship systems in which the young have learned to imitate the beliefs and behaviors of a given group. Teachers have worked within schools of thought, cults, monasteries, and other types of organizations to shape beliefs, knowledge, and behavior. Such philosophical and religious leaders as the Buddha, Confucius, Pythagoras, Jesus Christ, Moses, Muhammad, and Karl Marx instructed their disciples through informal organizations.

Ancient Education

Near East. The nature of education in Egypt and Sumer as early as the early 3d millennium BC is known from archaeological evidence. Various young people were selected to serve as priests, clerics, builders, and political rulers. They were taught writing, mathematics, astronomy, architecture, and government in temple schools run by priests. Hebrew education centered on the study of the TORAH and adherence to its teachings and principles. The Bible and documents such as the Dead Sea Scrolls have provided much information about education in ancient Palestine. One Jewish caste, the Levites, at an early time became temple servants and teachers of the law. Scholars known as scribes and later as rabbis taught in the synagogues, although a major responsibility for the education of children fell on parents.

China and India. In ancient China cultural leadership centered around the royal courts. Chinese historians have traditionally reported on the Hundred Schools of thought that emerged from these courts about 1000 BC. Up to about 600 BC formal education was available only to rulers and nobles; after that time it became more widespread among officials and members of the wealthier classes. By 400 BC, education, usually conducted in private homes, was largely shaped by four schools of thought: CONFUCIANISM, DAOISM, Mohism, and Legalism. Accompanying the ascendancy of Confucianism during the Han dynasty (202 BC–AD 220) was a strong surge of interest in education and intellectual pursuits. In AD 124 a Grand College was set up to train candidates for the civil service; they were selected by a rigorous examination system that held sway in China into the 20th century.

The older societies of India were largely conquered by Aryan groups between 2000 and 1500 BC. The Aryans developed the VEDAS, a body of scripture that divided society into castes. Under the caste system, which became a vital part of HINDUISM, social function was inherited; one was obliged not only to learn certain things by formal instruction and apprenticeship, but, by the moral code, not to learn others. One member of the warrior caste, Prince Siddhartha Gautama (*c.*560–480 BC; see BUDDHA), sought a spiritual life and developed the precepts that became known as BUDDHISM. By the 3d century BC his disciples, living as monks, exerted great influence across all of India. Between the 1st and 7th centuries AD Buddhism became a major religious and educational force in Tibet, China, Japan, and Southeast Asia.

Greece and Rome. In ancient Greece societal values were transmitted in various ways. Homer's epic poems the *Iliad* and the *Odyssey* described the idealized behavior of a people who were destined to conquer and rule. Schools of thought were established by such teachers as Thales of Miletus, who is known as the first Western philosopher; Pythagoras of Samos, who established a religiously oriented cult; and the statesman Solon, who emphasized politics and economics.

In Sparta state institutions trained boys almost exclusively in the military arts. Any academic learning was provided by private tutors. In other Greek city-states boys received a general education before beginning military training. The Athenians in particular strove to educate the complete individual. Parents employed teachers in a wide range of subjects. In 5th-century BC Athens the Sophists, teachers who took fees for their lessons, filled an educational gap. Protagoras, who taught mathematics, politics, ethics, and metaphysics, was a philosopher and a rhetorician. He and other Sophists taught rhetoric, an important subject for aspiring statesmen. Socrates went one step further: he engaged his students in dialogues about ethics and politics, and he asked no fees.

The Academy, established by Socrates' disciple Plato about 387 BC, might be considered among the first universities, if a university can be defined as a place where scholars conduct rigorous research together with their students. Another university of this type was the Lyceum, founded by Aristotle in 335 BC. The philosophies of Plato and Aristotle dominated educational thought for centuries and continue to exert an influence on education today.

Many Roman leaders sought their advanced education in Greece or, after the mid-3d century BC, in Roman schools that were modeled after the Greek. Rome also produced teachers of engineering, architecture, and law. In ancient Rome boys were given a general education that included the study of literature, linguistics, astronomy, geometry, music, logic, history, and philosophy; girls received only an elementary education.

The impact of Greek and Roman education was strong and long-lasting in Western culture. In medicine, Hippocrates founded a research-oriented school at Cos in the 5th century BC. He was followed in the 2d century AD by the Roman physician Galen. For many centuries their medical science was the most advanced in the West. The rhetorical school of Isocrates became a model for such Romans as Quintilian and has long influenced the study of the humanities. Christians received the same classical instruction as pagans.

Medieval Education, 600 to 1400

After the fall of Rome in AD 476, the Eastern Roman Empire, with Constantinople as its capital, continued to thrive as an intellectual and educational center. Classical Greek and Latin literary, philosophical, and scientific texts and traditions were preserved there, and the teaching of these subjects formed the basis of education until the fall of Constantinople to the Ottoman Turks in 1453. Prominent among early Byzantine educators was Martianus Capella, who in the mid-5th century categorized knowledge into two areas: the *trivium* (grammar, logic, and rhetoric) and the *quadrivium* (arithmetic, astronomy, geometry, and music). Today's legal scholars still study the *Corpus Juris Civilis* (529–35), Emperor Justinian's codification of Roman law.

Western Europe. During the Dark Ages, which extended from the fall of Rome to the beginning of the Carolingian revival (*c.*770), education nearly came to a standstill in western Europe. What formal education existed was religious in nature and provided by monasteries, mainly in Ireland and northern England. Charlemagne supported education in the hope of forming one great Christian empire of all the Germanic peoples. He invited (*c.*781) Alcuin, principal of the great cathedral school at York, England, to set up a palace school at Aachen. Alcuin's palace school became the model for other centers of learning in the Carolingian empire.

In early medieval Europe a nobility skilled in warfare controlled some aspects of education. Under the system of chivalry, which reached its zenith in the 13th century, a young man would serve as a page and then as a squire before he could become a knight. He would read such literature as the chansons de geste and the legends of King Arthur in order to learn morality and courtly virtues.

In western Europe, however, most formal education at this time was provided by the church. The basic tenets of Christianity were taught in catechetical schools, which flourished for the first eight centuries AD. Further education was provided in monasteries, many of which followed the rules set forth by Saint Benedict in the 6th century. Cathedrals also maintained schools to educate priests and secular leaders. The curriculum in these schools was based on the *trivium* and the *quadrivium.*

From the beginning of the Christian era many people learned medicine through apprenticeship, although a major school of medicine existed at Constantinople. At Salerno, Italy, a medical school developed as early as the 9th century. Montpellier, Paris, and Padua also became centers of medical education.

Education in Italy was not controlled by the church, although there were church schools and clerical teachers. In Italy the study of classical literature and texts prevailed over religious studies. This facilitated the development in the 11th century of law and medical schools at Bologna and Parma. Important scholars of the time were Irnerius (*c.*1055–*c.*1130), a great civil-law scholar, and Gratian, who taught canon law. Italian students were well organized and participated in managing their universities.

In France and northern Europe, the dominant influence on university development came from Paris, where large communities of scholars developed in the cathedral schools and the monastic orders. One of the most distinguished members of these communities was Peter Abelard, who taught at the cathedral school of Notre Dame, out of which the University of Paris emerged in the 12th century. The celebrated Sorbonne was founded in the next century at Paris, which became a great center for education, especially in theology. The Dominican scholar Saint Thomas AQUINAS taught there. His synthesis of Aristotelian thought with Christianity has since dominated Roman Catholic philosophy and has been critically important to subsequent European philosophies of education.

The universities at Oxford and Cambridge developed in a similar manner. Indeed, some of the original students and faculty members at Oxford had branched off from Paris, and those of Cambridge came from Oxford.

The Rise of Islam. By the mid-8th century, the dynamic new religion of ISLAM extended from the Near East to India and Spain. In some Islamic schools reading, writing, and mathematics were taught; some added courses for social improvement, and some offered only discussion and debate. Research centers and universities established at Baghdad, Cairo, Alexandria, Córdoba, and other cities flourished. Muslim education included the study of the KORAN as well as such secular fields as engineering, architecture, medicine, astronomy, and geography. Muslim scholars encouraged visits from foreign scholars and translated foreign classics into Arabic. They also translated their own scientific treatises into Latin, making such knowledge available to Western scholars.

Advances in education arose from the interchange of ideas in the Muslim world. The Muslim mathematician al-Khwarizimi (d. *c.*835) greatly advanced the science of mathematics by introducing a numeral system that had first been developed in India and that would later be known as the Arabic number system. The Muslim medical scientists al-Razi (AD 865–925) and Ibn Sina (AVICENNA) advanced the thought of Galen. Like the Jewish scholar MAIMONIDES, the Muslim Ibn Rushd (AVERROËS) studied the relationships between Aristotle and the new religions, Christianity and Islam. For many generations Jewish and Christian scholars worked alongside Islamic scholars in Baghdad and Spain.

Early Modern Period, 1400 to 1800

With the development (*c.*1436) of movable type, it became possible to publish books in large quantities and to disseminate knowledge more quickly and widely. Other changes were also afoot in Europe that were to have a strong impact on education.

The Renaissance and Reformation in Europe. The RENAISSANCE of humanistic literature got under way in Italy during the 14th and 15th centuries with PETRARCH, and, later in the Netherlands, with Desiderius ERASMUS. Essays such as Nicolò MACHIAVELLI's *The Prince* (1532), Baldassare CASTIGLIONE's *The Courtier* (1516), and Erasmus's *The Education of a Christian Prince* (1516), together with the writings of François RABELAIS and Michel de MONTAIGNE, urged new patterns of education. Humanistic schools for the aristocracy were founded in Italy, France, and England at this time. In Germany, the GYMNASIUM was set up. Some schools were also established for children of nonaristocratic families.

The Protestant REFORMATION, led by Martin LUTHER and John CALVIN, occurred in the 16th century. Both believed that it was important for all Christians to read the Bible. They urged the state to establish an educational system. Followers of Calvin sought to maintain primary schools so that everyone could learn to read. Luther's friend Philipp MELANCHTHON was influential in advocating new national patterns of schooling.

At the same time a reformation (usually called the COUNTER-REFORMATION) was also taking place within Roman Catholicism. One of its leaders was IGNATIUS LOYOLA, who founded the Society of Jesus in 1534. The Jesuits established schools and colleges throughout Europe. In the 17th century JOHN BAPTIST DE LA SALLE established the Christian Brothers, who maintained an extensive system of Catholic schools for the poor. At Reims, they established a teacher-training institution.

The 17th Century. During the 17th century several theorists emerged who were to exert a continuing influence on education. Among them were Francis BACON, John Amos COMENIUS, and John LOCKE. Bacon greatly encouraged the scientific revolution of the time and helped convince many educators that the advancement of knowledge was beneficial to human society in general. Comenius had an encyclopedic view of what kind of knowledge was most important and talked about the relationship between the physiological senses and patterns of thought. Locke believed that each person gains knowledge of the world largely through experience, association, and sense perception, and not merely by memorizing facts and principles.

The discoveries of such scientists as Nicolaus COPERNICUS, GALILEO, William HARVEY, Johannes KEPLER, and Isaac NEWTON influenced the teaching of the various sciences. Little science was taught in schools or even in universities before 1700. Curricula usually consisted of writing, reading, grammar, history, mathematics, music, and religion. After 1700, however, advanced scientific and mathematical knowledge came to be taught in many schools and universities.

The Spread of Western Culture. In the British colonies in North America, the curricula of the earliest schools centered on religion. In 1642 the colony of Massachusetts passed a statute requiring that children be taught to read, a skill necessary to the understanding of the Bible. In 1647 a statute was passed stating that every community must establish a primary school and that larger communities must also maintain a secondary school. The earliest colleges founded in British North America were Harvard (1636), William and Mary (1693), and Yale (1701). Early American collegians studied grammar, logic, rhetoric, ethics, geometry, arithmetic, ancient history, Greek, Latin, and Hebrew.

In Latin America, Spanish missionaries founded elementary schools for the Indians in the 16th century. A few secondary schools were provided for children of Indian nobles and for Spaniards. The earliest universities, in Mexico (1551), Peru (1551), Colombia (1573), Argentina (1613), Bolivia (1624), and Guatemala (1676), were founded by the respective royal governments and also received the required papal decrees.

The 18th Century. The rudiments of national educational systems began to develop in the 18th century. In

France, Jean Jacques ROUSSEAU advocated letting children develop naturally—in direct opposition to the prevailing methods of teaching. Rousseau's beliefs, set down in *Émile* (1762), inspired those who later sought universal education that was free of church control.

During the Napoleonic Wars the Germans began to seek material that emphasized the distinctive elements of German culture. Among those involved in this nationalistic movement was Johann Gottlieb FICHTE, who advocated the comprehensive education of both boys and girls by means of strict moral training and encouragement of independent thought. Wilhelm von HUMBOLDT, a philologist, stressed that university students and teachers should be free to profess any religion without fear of reprisal and to pursue a humanist education for its own sake, and not merely for its usefulness to the state.

In 18th-century England, Andrew BELL and Joseph LANCASTER helped bring an elementary school system into being. Bell developed a systematic monitorial system, which Lancaster modified, whereby children taught other children in the classroom. This system did not encourage creative education, however, because the pupils participating in it were taught only to memorize the information given them.

Nineteenth-Century Education

During the 19th century various national school systems began to assume their modern forms. New theories of education had widespread impact.

Western Europe. Perhaps the most influential 19th-century educator was Johann PESTALOZZI of Switzerland, whose theories influenced modern elementary education. He wrote that education should develop a child's intellectual and physical powers to produce a complete and fully integrated personality. Another influential educator was Friedrich FROEBEL, who founded the kindergarten movement in Germany. Johann Friedrich HERBART, who established pedagogy as a science, saw education as being ideally a process of integrating a student's interest and social experience with the subjects to be learned.

At the beginning of the 19th century there was no unified system of primary and secondary education in Great Britain. Although schools formed by philanthropists and volunteers were common, they offered only a basic education. Public (that is, independent) schools such as Eton, Harrow, and Winchester provided a classical education, but only to those who could afford to pay a large tuition. The passage of the Elementary Education Act (1870) provided for voluntary schools throughout Great Britain, vested educational authority at the local level, and guaranteed that children would not receive religious instruction against their parents' wishes. Education became mandatory in Great Britain a decade later. No new universities emerged in Great Britain from the founding (1583) of the University of Edinburgh, which joined 5 older ones, until the mid-19th century, when civic universities were established at public expense in the developing industrial areas. Many teachers' colleges and technical schools had been founded by the end of the 19th century.

In France a law was passed in 1833 requiring the communes to provide elementary schools. Secondary education consisted at that time of languages, literature, history, geography, art, music, sciences, and mathematics. Girls received a modified version of boys' education in the secondary schools that were established for them in 1880. During the middle of the 19th century France set up 16 administrative educational units, each governed by a university, which was to provide secondary and higher education for its area.

Germany sought universal literacy and to achieve this provided free and compulsory primary education. The schools also taught religion. There were three types of secondary education in Germany: classical, taken at a gymnasium; semiclassical, with less emphasis on ancient studies; and one emphasizing sciences. German universities such as those founded at Berlin (1809), Bonn (1786), and Munich (1826; originally founded in 1471) were pioneers in changing and expanding their curricula to keep abreast of scientific advances. Research and teaching were skillfully and successfully combined, and these universities set a new world standard.

The United States. Primary and secondary education in the United States, always administered on the local level, varied greatly from state to state. Throughout New England the common school—forerunner of the public school—offered free primary education to all children. Americans placed a high value on public education. The Land Ordinance, passed by Congress in 1785, set aside a section of public land that potential new states could use for the support of public schools.

The expansion of public education through the establishment of state boards of education began in Massachusetts in 1837, largely through the efforts of Horace MANN. Henry BARNARD championed public schools in Rhode Island and Connecticut. Other states soon followed suit. The idea of the public high school did not take hold until the 1870s, although one opened in Boston in 1821 and was followed by several in other cities. Throughout the 19th century, however, secondary education was available at private academies.

Colleges and universities, which had grown in number by the end of the century, offered courses in the humanities, sciences, social sciences, and law. The oldest colleges no longer required heavy concentrations in theological studies. In 1862 the Federal government passed the Morrill Act, which set aside public land to support new state universities specializing in the agricultural and mechanical sciences—the LAND-GRANT COLLEGES.

Both in Europe and the United States, the new discoveries of such scientists as André AMPÈRE, Charles DARWIN, Michael FARADAY, and Louis PASTEUR were taught in schools and colleges. More sophisticated methods for conducting theoretical and experimental inquiry were developed. The works of such economists and social scientists as Adam SMITH, Thomas MALTHUS, David RICARDO, and Karl MARX were studied.

Elsewhere in the World. The European nations that had colonies in Africa and Asia—primarily Great Britain and France—set up elementary, secondary, and, later, higher education systems based on those at home. The intention was to provide the colonies with teachers, doctors, nurses, and civil servants. Some colonial subjects were able to receive a secondary and university education in Europe. When all of India came under British rule in 1857–58, primary and secondary education became more widespread there, and universities were established in Bombay, Calcutta, and Madras. Although many Indian leaders were educated in England, some advocated a system of education that would preserve Indian culture. Several colleges were founded for this purpose in the last quarter of the 19th century—for example, the Anglo-Mohammedan Oriental College (1875) in Aligarh.

Education in the Twentieth Century

In the 20th century major advances in education occurred throughout the world. School and college curricula have kept students abreast of developments in science and technology. Modifications of the ideas of Plato, Aristotle, Confucius, Rousseau, and others, plus new political philosophies (including the tenets of Marx, Mao Zedong, and Gandhi) and new systems of psychology as put forth by Ivan PAVLOV, G. Stanley HALL, Sigmund FREUD, Carl JUNG, Edward THORNDIKE, B. F. SKINNER, and Jean PIAGET, influenced new educational ideals. New systems of education—such as John DEWEY's and William JAMES's—that were to influence whole nations were developed. The idea of education for all became a rallying point for many social and political leaders, especially those of emerging nations, where widespread illiteracy often prevailed. During the second half of the 20th century, the majority of the world's nations committed themselves to providing education for all children.

The United States. Kindergartens, first set up in the second half of the 19th century, spread in the 20th, and school curricula were changed to enable children to be educated as individuals. Vocational schools taught skills that would enable graduates to compete effectively for jobs. In recent years the number of COMMUNITY AND JUNIOR COLLEGES has grown. They have educated students who are unable to attend more traditional 4-year colleges and have permitted adults to pursue studies, interests, or careers with no view toward a higher academic degree.

Other Countries. During the early 20th century, Western European countries experimented with various systems of primary and secondary education before making any real progress toward providing education on those levels to all children. After World War II politicians and educators renewed their efforts to provide high-quality secondary education for all. The secondary schools of Great Britain, France, Germany, and other European countries give all children a general academic education. The proliferation of colleges, universities, and special institutes has made the higher levels of education available to increasing numbers.

Social reforms in mid-19th-century Russia enabled children from all classes to attend school. Later in the century, a reaction to widespread education set in, with the result that by the time of the 1917 revolution more than half the Russian people were illiterate. After the revolution Communist educators viewed the establishment of free and compulsory education together with the expansion of professional and higher education as high priorities for the realization of Soviet goals in science, agriculture, and industry.

At the turn of the century, China abolished the traditional examination system and set up a modern school system. Since the Communist takeover in 1949, education has been made available to many more people and illiteracy has decreased. The main thrust of education in modern China has been to provide the skills necessary for meeting the economic needs of a backward country.

Education in Japan at the beginning of the 20th century was compulsory for 4 years; after World War II it became compulsory for 9 years. Universities emerged from missionary schools or were set up by the government. Japan provides higher education in all fields, and admission to universities is based on the results of rigorous examinations. Japan now has one of the most highly educated populations in the world.

education, primary see PRIMARY EDUCATION

Education, U.S. Department of The U.S. Department of Education, formerly the Office of Education, was established as a cabinet-level agency in September 1979. The department took over most of the education programs of the former Department of Health, Education, and Welfare, with which the Office of Education had been associated since 1953. The office was originally set up in 1867 to gather information about education. From 1869 to 1939 it was part of the Department of the Interior and from 1939 to 1953 was under the Federal Security Agency.

The Department of Education establishes policy and administers assistance to state and local institutions in the form of grants and programs for elementary, secondary, higher, and continuing education; emergency school aid; occupational, vocational, and adult education; education for Indians and for the disabled; and overseas educational activity.

education, vocational see VOCATIONAL EDUCATION

education of the exceptional see SPECIAL EDUCATION

Education of Henry Adams, The Far more than an autobiography, *The Education of Henry Adams* (privately printed 1907, published 1918) puts forth Henry ADAMS's dynamic theory of history as based on the principle of acceleration. The crux of the work lies in the chapter titled "The Virgin and the Dynamo," in which the author, a descendant of two U.S. presidents, explains that history is determined by the individual's relationship to some central symbolic force: for example, the unifying veneration of the Virgin in the 13th century and the ascendancy of the impersonal, dehumanizing machine in his own time. Looking into the future, Adams sees technology as the dominant factor in human life, which will make increasingly irrelevant the kind of humanistic values that informed his youth.

education of the handicapped see SPECIAL EDUCATION

educational measurement and testing Educational measurement is the use of tests and other devices to determine students' abilities, to measure what they have learned, and to judge the effectiveness of educational programs. Tests are used to select students for college and for graduate study; to admit lawyers to the bar and physicians to the practice of medicine; and to select teachers for the schools and employees for corporations. The results of educational measurement are used to evaluate school practices and social policies, often causing shifts in funding. In the United States alone, approximately 300 million standardized tests are administered annually.

Nonstandardized Tests

The earliest educational tests were measures of performance, and these are still used in music, art, physical education, pilot training, typing, accounting, home economics, and many industrial areas. Most testing in formal education, however, is based on words rather than physical performance. Most tutors and classroom teachers use oral quizzing to evaluate students' understanding of material. Job interviews today are often an oral quiz of mental ability, knowledge, and personality, and most doctoral programs still culminate in an oral defense of a written thesis. Educational pioneers became skeptical of oral tests as early as 1850. The American educator Horace MANN showed the superiority of written tests over oral ones in a brilliant discussion of what are now called validity, reliability, and usability, basic concepts of psychometrics (see PSYCHOLOGICAL MEASUREMENT). And in England, in 1864, the Rev. G. Fisher called for an objective, numerical scaling of educational performance.

The most common tests today are those given by individual teachers—usually quizzes measuring factual knowledge through recall or by means of a short-answer, matching, true-false, or multiple-choice format.

Course grades, assigned on the basis of such classroom tests, become an important educational measurement. When gathered in a grade-point average (GPA), course grades are heavily considered in admitting students to college, to graduate and professional schools, and sometimes to employment. High school GPA is the best single predictor of college grades.

Standardized Tests

Because of differing standards among high schools and colleges, grades from a particular school cannot be totally trusted to evaluate individuals, groups, or programs. For such purposes, a more objective measurement is required. Standardized tests are meant to be given under more uniform conditions than are teacher-made tests. Tests must be secure—not known in advance either to the students or to the teachers. Instructions to the students and the timing of each tested section must also be uniform. Standardized tests have been pretested, and questions are selected to be neither too easy nor too difficult. Questions must discriminate among students, that is, be answered correctly more often by high-scoring than by low-scoring students.

Scores and Norms. Standardized test scores are typically reported in terms of location within a norm group rather than in terms of the number of correct items (the raw score). Tests are designed to produce a NORMAL DISTRIBUTION, with a large number of students scoring in the middle and fewer at either the high or low end of the spectrum.

Today standardized tests are almost invariably multiple-choice. This format permits mechanical scoring and allows computers to calculate standard scores, interpret scores in terms of the norm group, gather the score information for a school or district, and distribute the results. Results may be sent to students, counselors, school superintendents, and college admissions officers.

To be useful such results must be in terms of norm groups chosen for reasonable comparisons. Third-grade standard scores will typically compare a child with other third-graders, often with a representative national sample. Testing companies may also provide norms for different states or regions, for boys and girls, and for racial and ethnic groups. If a student takes a reading-comprehension test and receives a grade-equivalent score of 4.5, this means that he or she scored as well as the middle of the fourth grade on such a norming sample. A percentile score of 92 means that the child performed better than 91 percent of that third-grade norm group. Among the tests normed for grade levels in this way are the Sequential Tests of Educational Progress (STEP), California Achievement Tests (CAT), Comprehensive Tests of Basic Skills, Metropolitan Achievement Tests, Stanford Achievement Tests, and SRA Achievement Series.

Admission Tests. College-admissions testing is normed for comparison with such groups as all college applicants or all high-school seniors. Thus the Scholastic Aptitude Test of the College Entrance Examination Board (SAT) and the American College Testing Program (ACT Assessment) supply standard scores and various percentile scores for each applicant. The SAT routinely scores verbal and mathematical ability and the application of English rules (and has optional tests for advanced placement in college subjects). The ACT Assessment reports on English usage, mathematics, reading, and science reasoning.

Similar testing programs exist for entrance to graduate and professional schools: GRADUATE RECORD EXAMINATIONS, Law School Admission Test, Medical College Admission Test, and the Graduate Management Admission Test (GMAT) for professional training in management and business.

Criterion-Referenced Tests. Some testers and educators have argued that test scores should depend not on norm groups but on whether students have mastered specific instructional goals. They reason that a student's position in a norm group does not reveal whether the student can in fact follow written instructions, say, or subtract two-digit numbers. For a truer evaluation, they believe, testing should be "criterion-referenced" rather than "norm-referenced." This view became the rationale for the NATIONAL ASSESSMENT OF EDUCATIONAL PROGRESS.

Current Issues

Educational testing, by attempting to measure and compare the achievements and qualifications of culturally and socially diverse individuals, has long been a controversial issue in U.S. education.

Disclosure. In response to criticism, a few U.S. states have adopted "truth-in-testing" laws, entitling those who take certain standardized tests to receive a copy of the test, of the scoring key, and of their own answers.

Competency Testing. Many states have passed laws requiring a specified level of test performance before high school students are allowed to graduate. This requirement is commonly measured by a "minimum competency test" (MCT) administered in the 11th or 12th grade. Some oppose MCT as unfair to low-scoring racial and foreign-language groups. And some believe that diagnostic testing should be initiated much earlier, allowing more time for remedial work.

Teacher Testing. Similarly, many states insist that teachers meet minimum standards of competency, as measured by tests. The most widely used is the National Teacher Examination (NTE).

Cultural Fairness. Objective testing proliferated, in part, from a desire to end discrimination in areas such as college admissions. Since the 1960s, however, some critics have claimed that important tests discriminated against African-Americans, Hispanics, women, and other groups whose cultural backgrounds and social roles differed from an expected norm. Following much research and many changes in item selection and screening, however, many test experts now believe that the widely used tests are not biased.

See also: BINET, ALFRED; TERMAN, LEWIS.

educational psychology Educational psychology applies psychological principles and methods to the solution of educational problems and the improvement of educational practice. Its major fields of investigation and application are behavior, cognition, and motivation; individual differences, development, and learning; heredity and environment; and the measurement and analysis of human characteristics and behavior. Closely related to educational psychology are the fields of EDUCATIONAL MEASUREMENT AND TESTING; educational guidance and counseling; and school psychology, which provides educational services such as diagnosis and remediation of learning difficulties.

Since the ancient Greeks, psychological views of the learner's needs have influenced educational theory and practice. In the United States, Edward L. THORNDIKE, who emphasized the effect of rewards on learning, is considered the father of educational psychology. In recent years, large-scale educational surveys and the synthesis of more than 8,000 studies of factors influential in learning have shown that nine major factors are involved in the ability to learn.

These fall into three groups: student aptitude, instruction, and psychological environments. Student aptitude includes (1) ability or prior achievement as measured by scores on educational tests; (2) psychological development as indexed by chronological age or stage of maturation; and (3) motivation or self-concept as shown by personality tests and students' perseverance on learning tasks. Instruction can be thought of as (4) the amount of time a student spends on learning; and (5) the quality of the instructional experience, including both the method of teaching employed and the content offered. Psychological environments include (6) the "curriculum of the home"; (7) the morale of the classroom as a social group; (8) the student's peer group outside the school; and (9) the amount of leisure-time devoted to television entertainment.

These factors are the chief influences on academic achievement and, more broadly, school-related cognitive, affective, and behavioral learning. Prior achievement, maturation, motivation, and an appropriate quantity and quality of instruction all seem necessary for learning to take place in school. Large amounts of instruction, for example, may count for little when students are unmotivated. The four psychological environments can similarly affect what and how much students learn. Good classroom morale raises the level of intellectual stimulation. Positive peer groups outside the school and stimulating home environments can enlarge learning time and enhance its effectiveness. Finally, noneducational TV can displace homework, reading, and other learning activities.

Educational Testing Service The Educational Testing Service (ETS), located in Princeton, N.J., is a private, nonprofit organization established in 1947 to research and administer educational testing. Founded by the American Council on Education, the Carnegie Foundation for the Advancement of Teaching, and the College Entrance Examination Board, ETS is best known for the admissions tests it prepares for higher education, including the Scholastic Aptitude Tests (SAT), the Graduate Record Examinations (GRE), and the Law School Admission Test (LSAT). ETS also prepares tests on the elementary and secondary level. Its Center for Occupational and Professional Assessment (COPA) designs tests for professional certification. Other ETS activities include preparation of standardized financial-aid applications for different levels of schooling and distribution of information about forms of financial aid. Its international activities include Peace Corps assessment and the design of tests for developing countries. It also conducts research in PSYCHOLOGICAL MEASUREMENT, child development, and educational policy and practices.

Edward, Lake Lake Edward, or Edward Nyanza, is in east central Africa on the border between Zaire and

Uganda. With a maximum length of about 80 km (50 mi) and a width of 42 km (26 mi), it covers 2,150 km^2 (830 mi^2) of a rift valley in the East African Rift System. Henry M. Stanley, who discovered it in 1889, named the lake for Edward, prince of Wales (later King Edward VII). The Rutshuru River is the feeder, and the Semliki River, flowing north to Lake Albert and then to the Nile, is the outlet. Uganda and Zaire have created national parks on both shores of the lake.

Edward, the Black Prince Edward, the Black Prince, b. June 15, 1330, d. June 8, 1376, was the eldest son of Edward III of England and father of Richard II. He was one of England's ablest commanders in the HUNDRED YEARS' WAR. His nickname probably was derived from the color of his armor.

Edward commanded the English forces in the victory at Poitiers (1356) and was subsequently (1362–71) ruler of Aquitaine, an English principality in France. In 1367 he invaded Spain and won a victory at Nájera; in 1370, after a revolt of his French subjects, he sacked Limoges. Shortly before his death he intervened in the so-called Good Parliament to ensure the succession of his son Richard to the English throne.

This engraving shows Edward, the Black Prince, the eldest son of King Edward III of England. The Black Prince (perhaps so named because of his black armor) fought in the Hundred Years' War and ruled (1362–71) the English principality of Aquitaine from his court at Bordeaux.

Edward the Confessor, King of England Saint Edward the Confessor, b. between 1002 and 1005, d. Jan. 5, 1066, was the next to last Anglo-Saxon king of England (1042–66). His reign prepared the way for the Normanization of England under WILLIAM I (William the Conqueror). The son of ÆTHELRED II, Edward was raised at the ducal court of Normandy. A weak king, he permitted the reins of regal power to pass into the hands of the house of Godwin, earl of Wessex. Godwin's son Harold (later King HAROLD II) was the effective ruler of England from 1053 to 1066. Westminster Abbey, which the Confessor rebuilt, was Edward's greatest legacy to his people. He was canonized in 1161.

Edward the Elder, King of Wessex The Anglo-Saxon king Edward the Elder, d. July 17, 924, unified most of England south of the Humber River. He succeeded his father, ALFRED, as king of WESSEX in 899 and continued the wars against the Danes. Conducting a series of joint campaigns with his sister, ÆTHELFLÆD of Mercia, he destroyed a Danish army in 910 and by 918 had virtually extinguished Danish power in England. On Æthelflæd's death in the same year, English Mercia was incorporated into Wessex. In 920, Edward received the formal submissions of Rægnald, the Scandinavian king of York; Ealdred, ruler of English Northumbria; the Welsh king of Strathclyde; and possibly Constantine II of Scotland. He was succeeded by his son Athelstan.

Edward I, King of England Edward I, b. June 17, 1239, d. July 7, 1307, king of England (1272–1307), completed the conquest of Wales and temporarily subdued Scotland. He was the eldest son of HENRY III. In 1254 he was made duke of Gascony and married Eleanor of Castile (d. 1290). In the disputes with the English barons following the institution of the Provisions of Oxford (1258), Edward supported Simon de MONTFORT in 1259 but later changed sides. He fought for the king at the Battle of Lewes (1264) and himself defeated Montfort decisively at Evesham (1265).

Becoming king in 1272, Edward conquered the Welsh principality of Llewelyn ap Gruffydd in 1277 and 1282–83 and built massive castles to keep it secure. In England he held regular parliaments, strengthened royal control over the court system and reformed the feudal land law.

After 1294, wars in Scotland and France dominated Edward's reign. The death (1290) of Margaret, Maid of Norway, heiress to the Scottish crown, allowed Edward as suzerain to choose a successor, John de BALIOL, and then to claim direct rule over Scotland, which he subdued in

One of the greatest medieval English kings, Edward I (r. 1272–1307) has been called the English Justinian for his legal and administrative reforms. Edward was also a great warrior king, who conquered Wales and temporarily subdued Scotland.

1296. In France the conflict concerned the French king's overlordship over Edward's duchy of Gascony. In 1297, Edward attacked France to assert his rights, but the expedition was cut short by the rebellion in Scotland of Sir William Wallace. At the same time the English nobles rebelled, forcing Edward to grant Parliament control over taxes. By a treaty (1303) with Philip IV of France, Edward retained Gascony. He failed, however, to quell the risings of Wallace and Robert the Bruce (later Robert I), and Scotland remained only half-conquered at his death. He was succeeded by his son Edward II.

Edward II, King of England Edward II, b. Apr. 25, 1284, d. September 1327, king of England (1307–27), was the first Plantagenet to be deposed. He was the son of Edward I and the first English prince of Wales. He married (1308) Isabella, daughter of Philip IV of France. Suspicious of Edward's close association with a Gascon knight, Piers Gaveston, leading magnates drew up the Ordinances of 1311, which enforced Gaveston's exile and placed limitations on the king's financial independence. When Gaveston returned he was executed (1312) by his enemies.

Edward recovered power with the help of a new favorite, Hugh Despenser, and defeated (1322) his enemies at Boroughbridge. The oppressive rule of Edward and Despenser that followed, however, was ended by an invasion from France by Queen Isabella and her lover, Roger de Mortimer (see Mortimer family), in 1326. The deposed Edward II, who was succeeded by his son, Edward III, was imprisoned and probably murdered.

Edward III, King of England Edward III, b. Nov. 13, 1312, d. June 21, 1377, king of England (1327–77), began the Hundred Years' War against France. At the deposition of his father, Edward II, his mother, Isabella, and her lover, Roger de Mortimer (see Mortimer family), took control. Edward married Philippa of Hainaut in 1328. In 1330 he executed Mortimer and began his personal reign.

The dangers of a French alliance with Scotland and French claims to Edward's duchy of Gascony led him to invade France and claim the throne by inheritance from his mother, who was the daughter of Philip IV of France. Between 1337 and 1340, he attempted to invade the Low Countries and Germany, but was forced to conclude a truce. His later strategy of raids was more successful. In 1346 he defeated the French at Crécy; he captured Calais in 1347. His son Edward, the Black Prince, rose to prominence as a result of an expedition that led to the defeat and capture of King John II at Poitiers in 1356. The Treaty of Brétigny (1360) ceded to Edward a greatly expanded Gascony.

Edward III succeeded to the English throne in 1327 when his father, Edward II, was deposed by his mother, Isabella, and her lover, Roger de Mortimer. Edward assumed personal control in 1330. His 50-year reign was marked by the early phases of the Hundred Years' War (1337–1453).

Edward's high military prestige, symbolized by the Order of the Garter, which he founded in 1349, later declined. French reconquest was begun by King Charles V in 1369. When Edward died in 1377, he was succeeded by his young grandson Richard II.

Edward IV, King of England Edward IV, b. Apr. 28, 1442, d. Apr. 9, 1483, king of England (1461–83), was the first monarch of the House of York. After defeating supporters of Henry VI at Mortimer's Cross and Towton, Edward was crowned king.

In 1464, Edward offended Richard Neville, earl of Warwick by his secret marriage to Elizabeth Woodville. Eventually, intrigues between Warwick, Edward's brother George, duke of Clarence, and Henry VI led to a rebellion that forced Edward to flee to the Low Countries in 1470, and Henry VI was restored to the throne. In 1471, however, Edward returned, defeated his opponents at Barnet, and captured Henry, who died shortly thereafter. The remainder of his reign was largely peaceful. At his death he left two young sons, Edward V and Richard, duke of York, who were almost certainly murdered on the orders of their uncle Richard III.

See also: Roses, Wars of the.

Edward V, King of England Edward V, b. November 1470, d. August 1483?, king of England (April–June 1483), was one of the two princes in the Tower. On the death of his father, Edward IV, he was brought to London. His uncle Richard, duke of Gloucester, then induced the queen, Elizabeth Woodville, to surrender Edward and his younger brother, Richard, duke of York. On June 25, their father's marriage was declared invalid and the boys therefore illegitimate. Gloucester was proclaimed king as Richard III, and Edward and his brother were probably murdered soon thereafter.

Edward VI, King of England Edward VI, king of England, b. Oct. 12, 1537, d. July 6, 1553, was the only son and successor of Henry VIII. Born to Henry's third wife, Jane Seymour, he succeeded to the throne on Jan. 28, 1547. The young king's uncle, Edward Seymour, duke of Somerset, assumed control as protector. In 1549, Somerset fell from power and John Dudley, duke of Northumberland, became regent.

Edward favored Protestant reforms in the Church of England (see ENGLAND, CHURCH OF). The BOOK OF COMMON PRAYER, compiled by Archbishop Thomas CRANMER, was first published during his reign. Edward's half sister Mary, a Roman Catholic, succeeded him as MARY I.

Edward VII, King of England, Scotland, and Ireland Edward VII, b. Nov. 9, 1841, d. May 6, 1910, was nearly 60 years old when he succeeded his mother, Queen Victoria, in 1901. As Prince of Wales, he acquired a reputation as a playboy and was heartily disapproved of by his mother. Later he and his wife, Alexandra of Denmark, presided over an unconventional social set that included members of the upper middle classes as well as the aristocracy.

Although when he succeeded to the throne he had little experience in government, Edward was extremely popular during his short reign (1901–10). He went on many state and informal visits to Europe and Ireland, and he helped conclude the Entente Cordiale (1904) with France.

Domestically, Edward leaned toward the Liberals but looked apprehensively on the constitutional and fiscal policies of Herbert ASQUITH and David LLOYD GEORGE, fearing that they would intensify class conflict. At the end of his life, he was vainly trying to mediate the conflict between the Liberal government and the House of Lords.

Edward VII succeeded his mother, Queen Victoria, to the British throne in 1901 and reigned until his death in 1910. With his wife, Princess Alexandra of Denmark, he performed ceremonial functions from 1861 on but was denied political responsibility until his mother's death.

Edward VIII, King of England, Scotland, and Ireland Edward VIII, b. June 23, 1894, d. May 28, 1972, was the only British monarch to abdicate voluntarily. As prince of Wales from 1910 until he succeeded his father, GEORGE V, on Jan. 20, 1936, Edward traveled widely and was very popular with British subjects throughout the empire. After becoming king, however, he found himself at odds with the government of Stanley BALDWIN over his determination to marry Wallis Warfield Simpson, an American divorcée. When it became clear that this marriage would not be accepted by either the political leaders or, probably, the public, Edward announced his abdication in a moving radio address on Dec. 11, 1936. Given the title of duke of Windsor, the former king married (June 3, 1937) Mrs. Simpson and lived with her in France, except during World War II, when he served as governor of the Bahamas.

Edwardian literature Edwardian literature refers to the literary production in England between 1901 and 1910, during the reign of Edward VII. The term is usually applied to a group of writers that includes novelists H. G. WELLS and Arnold BENNETT, playwright and novelist John GALSWORTHY, and playwright George Bernard SHAW. Edwardian literature demonstrates their reaction against the standards and certainties—especially in religion—of the Victorians, but they were also united in their desire to analyze contemporary society and shared an interest in the practical side of life, such as politics.

The term also loosely refers to writers whose individual achievement originated in the period before World War I— T. S. ELIOT, E. M. FORSTER, James JOYCE, D. H. LAWRENCE, W. B. YEATS, and many others. Such writers were responsible for innovation in drama, poetry, and the novel, and for introducing changes in technique, subject matter, and form. They had in common the idea of the seriousness and importance of their art, and, in this, appeared to react against the DECADENCE of the writers of the 1890s, such as Oscar WILDE.

Edwards, Jonathan Jonathan Edwards, b. East Windsor, Conn., Oct. 5, 1703, d. Mar. 22, 1758, was one of the most significant religious thinkers in American history. Experiences during the GREAT AWAKENING convinced Edwards that allowing unconverted persons to participate in the Lord's Supper was wrong. After his congregation, in Northampton, Mass., voted to dismiss him rather than abandon this custom, Edwards became a

Jonathan Edwards, the foremost theologian of the Great Awakening, combined the rationalism of the Enlightenment with an emphasis on personal religious experience, producing an influential body of religious writings.

missionary to Indians at nearby Stockbridge and wrote four of his most profound theological works.

Edwards's thinking combined two intellectual traditions. He defended standard doctrinal categories of the Puritan (see Puritanism) tradition, but he did so by using contemporary ideas from the British philosophers who helped inaugurate the Enlightenment. Drawing upon John Locke, he argued that current psychology vindicated the doctrine of man's total dependence on God. Since man's mind is originally a *tabula rasa* ("blank slate") on which his practical experience records impressions, and since God controls the destiny of every individual, human understanding can be considered to be the product of what God determines a person should experience. Edwards's reading of Isaac Newton also supported traditional convictions about the supremacy of God and the helplessness of man in the face of causes that lie beyond human control.

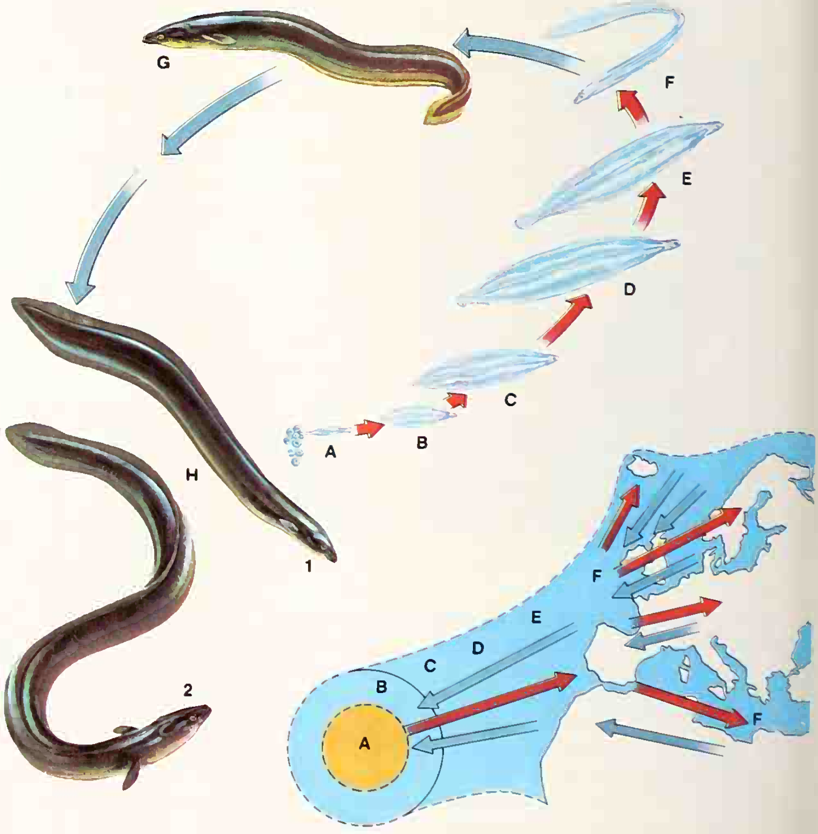
Blending his belief in the mystical nature of God with the logic of his day, Edwards also upheld the doctrines of original sin, lack of free will, the need for saving grace, and God's arbitrary choice in granting grace. His most famous works include the electrifying sermon "Sinners in the Hands of an Angry God" (1741), *A Faithful Narrative of the Surprising Works of God* (1737), and *Freedom of the Will* (1754).

eel Eel is the common name for about 400 species of mostly marine snakelike fishes generally inhabiting shallow waters throughout the world. Eels lack pelvic fins, and the dorsal and anal fins are elongate and tend to join with the tail fin to form one continuous "fin" around the body. All but 3 of the 22 marine families are scaleless. One freshwater family of eels has tiny, barely visible scales. Like frogs, freshwater eels have dense networks of blood vessels in their skin and can absorb oxygen directly from air or water.

Eels constitute the order Anguilliformes. One suborder, Anguilloidei, includes the snake, worm, freshwater, conger, and moray eels. The other suborder, Saccopharyngoidei, includes deep-sea forms. Among other fishes also called eels are the spiny eel and electric eel (see electric fish).

Snake and Worm Eels

The snake and worm eels, family Ophichthyidae, are the most highly evolved burrowing forms. They have long, pointed snouts; pectoral fins are reduced or absent; and gill apertures are often restricted to very small openings. All lack scales; many lack caudal fins, possessing instead a sharp-pointed tail for burrowing into sand, mud, or shell hash. The garden eels, subfamily Heterocongrinae, have



Adult eels spawn in the Sargasso Sea (A), *east of the Bahamas, and then die. Each lay as many as 100,000 eggs. The eel larvae, called* leptocephali (drawn to actual size), *are flat and transparent. They grow and change shape as they drift northward with the Gulf Stream toward Europe and North America. The various growth stages of the larvae and the sites at which these larvae are normally found during migration are represented at the age of 2 months* (B), *8 months* (C), *1 ½ years* (D), *and 2 ½ years* (E). *Three years after spawning they reach the European coast. It takes them only 1 year to drift to North America. They change into elvers, or glass eels* (F), *and travel inland along rivers. During their growth in fresh water they are called yellow eels* (G). *Between 4 and 10 years of age adult eels change from yellow to silver* (H). (G and H are not drawn to scale.) *Letters in the map correspond to stages of growth. Males* (1) *and females* (2) *begin to migrate back to the Sargasso Sea spawning grounds* (blue arrows); *very few from Europe reach the area. Eels from U.S. waters spawn in the mid-Atlantic.*

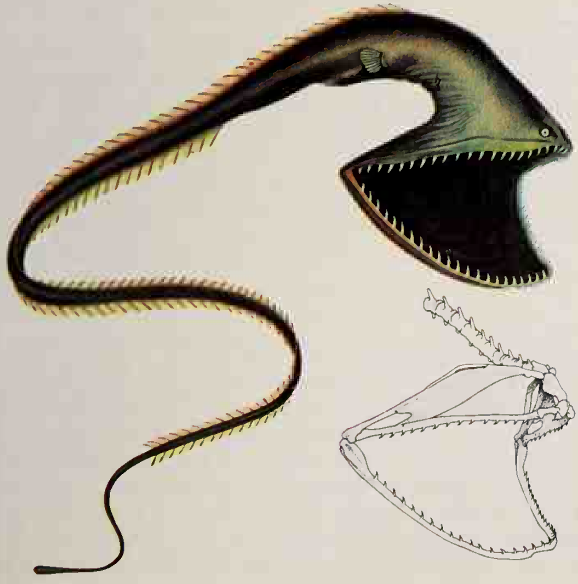
The conger eel, a marine fish of rocky coasts except the west coast of the Americas, is the largest eel. It commonly grows to 2 m (6 ft) in length and 35 kg (77 lb) in weight. Exceptional congers have been weighed at more than 100 kg (220 lb).

large eyes, are extremely slender, and are 30 to 50 cm (12 to 20 in) long. They usually live in tropical seas, on sandy slopes. They remain buried at night, but during the day they extend out of their burrows to feed on small planktonic animals.

Freshwater and Conger Eels

The freshwater and conger eels, families Anguillidae and Congridae, respectively, usually have well-developed pectoral fins and minute embedded scales. The Anguillidae are catadromous—that is, they spend most of their life in fresh water but return to the sea to spawn (see ANIMAL MIGRATION). The Congridae are marine and commonly live at depths to about 150 fathoms (270 m or 900 ft). Some species of congrids, such as *Conger conger,* supposedly attain a length of about 3 m (10 ft).

The gulper, or swallower, eel, found at depths to 3,000 m (10,000 ft), has huge jaws, sharp teeth, and a large distensible stomach enabling it to eat prey larger than itself. To swallow, it moves its jaws in a seesaw fashion and draws itself over the victim. The gulper is about 2 m (6 ft) in length.



Freshwater eels comprise 16 species found mostly in the Indo-Pacific region, with none in the eastern Pacific or southern Atlantic. The better-known species are the European eel, *Anguilla anguilla*; the American eel, *A. rostrata*; the Japanese eel, *A. japonica*; and the Indian eel, *Phisodnopsis boro.*

The European and American eels have a remarkable spawning migration. At about 10 years of age, when they are black with silvery white underparts and sufficiently fattened, most cease feeding and begin a seaward journey. They head for the Sargasso Sea, a sluggish area containing much seaweed, in the western Atlantic near Bermuda. The eels spawn; each female lays up to several million eggs. After spawning, the eels die. The newborn eels become leptocephali larvae; about 6 mm (0.2 in) long, they are transparent, have a leaflike shape and long needlelike teeth, and feed on plankton. By swimming and drifting with the currents, the leptocephali move past the east coast of North America, where the American species moves to shore; the others continue on toward Britain and western Europe. During the journey the leptocephali grow, changing into elvers, or glass eels, which are miniatures of the adults. As they grow larger they become olive brown with yellowish undersides. After several years they change into the black and silvery forms for migration.

Conger eels and freshwater eels are fished commercially for human consumption. Large congrids incidentally taken by shrimp fishermen off the Latin American coast are commonly sold in fish markets. Freshwater eels are taken wherever they occur, with hook and line and various traps.

Deep-Sea Eels

The deep-sea eels, families Saccopharyngidae (swallowers), Eurypharyngidae (gulpers), and Monognathidae, are found mainly in the Atlantic, Pacific, and Indian oceans at depths ranging from 2,000 to 5,000 m (about 7,000 to 17,000 ft). Adaptation to existence at such depths has greatly modified these unusual animals (see DEEP-SEA LIFE).

Swallower and gulper eels look like huge mouths with tiny eyes in front and a long, black body attached. The bodies lack most bones; the Monognathidae, which have only a small mouth opening, lack an upper jaw as well. Some swallower species may reach a length of 2 m (6 ft). Their stomachs are so flexible that they can swallow fish larger than themselves. The smaller, more fragile gulpers have tiny teeth and may feed by swimming with mouths gaping like nets to snare small invertebrates.

eelworm see NEMATODE

egg An egg, ovum, or female gamete is the female reproductive cell in sexually reproducing organisms. In sexual REPRODUCTION, the egg unites with its male counterpart, the SPERM cell, in the fusion process of FERTILIZATION to form the first cell of the new organism (see DEVELOP-

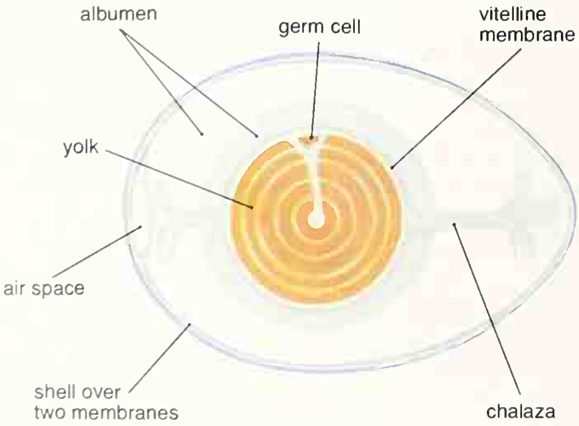
MENT). The egg contains half the chromosomes required by the new organism; the sperm supplies the other half. In higher animals the egg is larger than the sperm, and it does not move about by means of a flagellum, as a sperm does. The egg can also take part in asexual reproduction through PARTHENOGENESIS, in which the egg develops into a new individual without fertilization by a sperm cell.

Oogenesis is the process of forming the mature egg. In higher plants and animals, oogenesis occurs in specialized reproductive organs called ovaries. Mature eggs may be fertilized within the female body or externally after release, and may be coated with a hard or soft shell. In oviparous animals such as most fish and frogs, fertilization and development occur externally; the eggs have a jellylike coating. In other oviparous animals, such as most reptiles, the birds, and monotreme mammals, the eggs are fertilized internally and then enclosed in tough membranes and calcareous shells and released. The young develop and hatch after an incubation period. In some snakes the fertilization occurs internally and the eggs hatch just before laying; such animals are said to be ovoviviparous. In viviparous animals, including all placental mammals, the processes up until birth occur internally, and the egg is enclosed by a transparent membrane.

Animals vary greatly in the size of their egg cells and in the numbers produced at a single time. Among the largest eggs are those of the ostrich, averaging 18 cm long by 13 cm wide (7 in by 5 in). The human egg, by contrast, is about 100 microns (0.004 in) in diameter. Among higher animals, some turtles may lay from 200 to 300 eggs in a single clutch, and some fish lay many millions of eggs in a single spawning period. In human beings, a single egg is usually released from one of the ovaries during each menstrual cycle.

The relative amount of yolk, which contains nutritive materials for the developing embryo, varies. Bird and reptile eggs have the most yolk, as these animals reach an advanced stage of development before hatching. Fish eggs have much less nutritive material, since fish hatch as self-feeding, free-swimming embryos.

A chicken egg contains a large proportion of yolk, the main source of food for the embryo. The albumen, or egg white, provides additional nourishment; the chalazae help keep the egg cell in the center of the egg; the shell and various membranes protect the egg cell.



egg production The egg industry annually produces more than 68 billion chicken eggs in the United States, and a total of about 500 billion eggs throughout the world. Laying flocks range in size from a few hens to huge factory-farm units (see also FACTORY FARMING; POULTRY).

U.S. eggs are sized in categories ranging from pee wee (425 g/15 oz per dozen) to jumbo (850 g/30 oz per dozen minimum weight) and are graded for freshness, soundness of shell, and absence of interior defects. Quality grades of eggs sold at retail are AA, A, and B. Eggs are cooled to less than 10° C (50° F) and should be kept at cool temperatures until used—optimally, within 21 days of production.

The bulk of all eggs produced in the United States are sold fresh, in the shell. Eggs may also be sold in liquid, frozen, or dried form. All uncooked egg products that are carried interstate must be pasteurized during processing and then handled aseptically. Most dried egg products are dehydrated by spray-drying (see DEHYDRATION, food).

Annual U.S. per capita consumption of eggs has dropped in recent decades, from 330 in 1960 to about 240 in 1990. Much of the lowered consumption may be traced to the decreasing costs of other high-protein foods, such as meat. In addition, because egg yolks contain relatively large amounts of cholesterol, the desire to lower cholesterol intake no doubt accounts for some of the decrease in consumption. (The average large egg contains 213 mg of cholesterol.)

A virulent strain of salmonella, *S. enteritidis*, has been found in some eggs and has caused food poisoning. Consumers should avoid eating raw or undercooked eggs.

Eggleston, Edward [eg'-ul-stuhn] An American clergyman, novelist, and historian, Edward Eggleston, b. Vevay, Ind., Dec. 10, 1837, d. Sept. 2, 1902, was among the most significant pioneers of midwestern regional fiction. His best novels include *The Hoosier Schoolmaster* (1871), notable for its realism and handling of dialect; *The Circuit Rider* (1874), which deals with the impact of Methodism on the frontier; and *The Hoosier Schoolboy* (1883), primarily an attack on rural education.

eggplant The eggplant, or aubergine, *Solanum melongena esculentum*, is grown for its large oval fruit, which is eaten as a vegetable. It is a member of the Solanaceae family, which also includes the potato, tomato, and pepper. Native to India and China, the vegetable was introduced to Europe by Arabic traders. A perennial in nature, it is cultivated in colder climates as a frost-susceptible annual. Its stout, branching stems grow to about 1 m (3 ft) and bear broad, ovate, sometimes spiny leaves. Soli-

The eggplant needs a warm climate to mature its heavy, 30-cm-long (10-in) fruit. The eggplant's floppy leaves are lined with tiny, soft hairs. The stems that support the fruit are stout and spiny, requiring a knife or shears to sever.

tary lavender flowers develop—in the varieties most commonly grown in the United States—into large, fleshy, dark purple fruit. Small-fruited, variously colored varieties have also become widely available in recent years.

Egk, Werner [ek] Werner Egk, b. May 17, 1901, d. July 10, 1983, was a German composer best known for his operas. His first opera, *Die Zaubergeige* (The Magic Violin), was initially performed in 1935. Later works include: *Peer Gynt* (1938); *Columbus* (1941); *Irische Legende* (Irish Legend, 1955); *Der Revisor* (The Inspector General, 1956), after a play by Nikolai Gogol; and *Die Verlobung in San Domingo* (1963).

eglantine [eg'-luhn-tyn] Eglantine, or sweetbrier, *Rosa eglanteria*, family Rosaceae, is a dense shrub found in wasteland hedges. It has many strong, hooked prickles; the leaves are alternate; and the leaflets are covered with sticky sweet-smelling glands. The pink flowers are single; the fruits are globe-shaped and scarlet or orange red.

Eglevsky, André [eg-lev'-skee] André Eglevsky, b. Moscow, Dec. 21, 1917, d. Elmira, N.Y., Dec. 4, 1977, was, with Igor Youskevitch, the outstanding male dancer of his generation in the West. In 1936 he created the role of the Young Lover in Mikhail Fokine's *L'Épreuve d'amour* (The Trial of Love) for René Blum's Ballets Russes de Monte Carlo. After dancing with Ballet International, Leonid Massine's Ballet Russe Highlights, and Ballet Theatre, (later American Ballet Theatre), Eglevsky performed (1947–50) as the indisputable star of the Marquis de Cuevas's Grand Ballet de Monte Carlo. A member of New York City Ballet from 1951 to 1958, he created leading roles in several ballets by George Balanchine, including *Scotch Symphony* (1952) and *Caracole* (1952; now revised as *Divertimento No. 15*). In 1958 he founded his own ballet company in Long Island, N.Y.

ego *Ego*, the Latin word for "I," is a person's conception of himself or herself. The term has taken on various shades of meaning in psychology and philosophy. In psychoanalysis, the ego is a set of personality functions for dealing with reality, which maintains a certain unity throughout an individual's life. Sigmund FREUD, with whom the concept is closely associated, redefined it several times. In 1923, Freud used the term to refer to the conscious, rational agency in his famous structural model of the mind; powered by the instinctual drives of the id, the ego imposed moral restraints derived from the superego. After Freud's death, several of his associates, including Anna FREUD and Erik ERIKSON, extended the concept of ego to include such functions as MEMORY, sensory abilities, and motor skills.

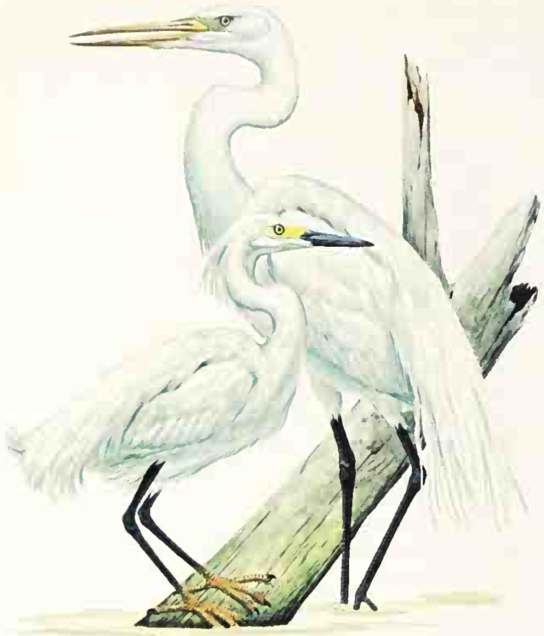
Some behavioral psychologists have adopted the psychoanalytic concept of ego strength—the degree of the ability to adapt oneself to reality. By measuring variables such as self-control, the ability to anticipate the future, and the capacity to focus attention, they have found that a stable family life tends to produce greater ego strength in children.

In PHENOMENOLOGY, ego refers to a person's conscious awareness of his activity, identity, oneness, and uniqueness. If these ego functions fail, the person may experience psychological fragmentation.

egoism In ethics, egoism is the theory that the promotion of one's own interest, rather than the interest of others, is the end and motive of conduct. Egoism was originally the psychological theory that the real goal of behavior is the agent's own pleasure and welfare coupled with the ethical claim that such self-interest is morally justified. This view served as the foundation for Thomas HOBBES's social contract theory of government and was widely held during the 17th and 18th centuries, providing a basis for LAISSEZ-FAIRE economic theory.

Joseph BUTLER was the first major critic of this position, claiming that the psychological component was defensible only if one confused the sense of satisfaction occasioned by a fulfilled desire with the object fulfilling it. Butler gave an independent status to the ethical claim that an agent's welfare is the sole criterion of right and wrong. Although most philosophers have rejected such ethical egoism, they have found it difficult to disprove.

egret [ee'-gret] An egret is any of the slender, long-bodied, usually white birds of the HERON family, Ardeidae, that grow long, decorative plumes (the aigrette) in breeding season. The great egret, *Casmerodius albus*, of the world's temperate and tropical zones, and the New World snowy egret, *Egretta thula*, were once almost eliminated



Egrets, a species of heron, were nearly destroyed during the 19th century by hunters, for their plumes were highly prized as hat feathers. The snowy egret (left) *has plumes on its head and back; the great egret* (right) *has long, silky tail feathers. Both species live in colonies near freshwater marshes.*

in America by plume hunters supplying the millinery trade, but they have survived under strict protection. The stockier cattle egret, *Bubulcus ibis*, of Eurasia and Africa, has extended its range in recent decades to South America, Australia, and North America.

Egypt Egypt is a nation occupying the northeastern corner of Africa, the Sinai Peninsula in adjacent Southwest Asia, and some islands in the Gulf of Suez and the Red Sea. It is bounded by the Mediterranean Sea on the north, Sudan on the south, the Red Sea and Israel on the east, and Libya on the west. The name *Egypt* is derived from the Greek word *Aegyptus*, which was taken from the ancient Egyptian term *Hik up tah* ("House of the Spirit"). The term was used to designate the city of Memphis, Egypt's earliest capital.

Egypt is the most populous nation in the Arab world and (after Nigeria) the second most populous country in Africa. Cairo, Egypt's capital, is the largest city in both Africa and the Middle East. Over 96% of Egypt's population live along the narrow, fertile Nile River valley and its delta, which accounts for only 4% of the total land area. Egyptians' strong identity extends back to the 4th millennium BC when the ancient Egyptian civilization was established.

Land and Resources

Egypt can be divided into four major physiographic regions: the Nile Valley and Delta, the Arabian Desert, the Libyan Desert, and the Sinai.

The Nile River valley is about 1,530 km (950 mi) long. In the south the valley is rarely more than 3 km (2 mi) wide. North of Edfu (Idfu) the valley widens, merging with the fertile delta from Cairo to the north. Southwest of Cairo, a large depression called the Faiyum Depression was left when ancient Lake Moeris evaporated. Today Birket (lake) Qarun, a shallow lake, occupies part of the depression, which is extremely fertile.

The Arabian Desert (known in Egypt as the Eastern Desert) is an extension of the Sahara. It consists of a plateau that slopes upward from the Nile to heights of about 600 m (2,000 ft). On the east it is bordered by a range of jagged mountains. There are few oases, and the region is sparsely populated. The southern part of the Eastern Desert, the Nubian Desert, is a rocky plateau extending south into Sudan. The Sinai Peninsula is also part of the Eastern Desert. In the south the Sinai is a highland dominated by Jabal Katerina at 2,642 m (8,668 ft)—the highest mountain in Egypt.

The Libyan Desert (known in Egypt as the Western Desert) is a great arid plain, most of it lying below 300 m (1,000 ft). Great sand-dune formations form an effective barrier along the Egyptian-Libyan border. The southern part of the Western Desert has no oases or settlements. To the north is a series of depressions; the Qattara Depression, covering about 18,100 km^2 (7,000 mi^2), is 133 m (436 ft) below sea level.

Soils. Most of the farmland of Egypt is limited to the Nile Valley and Delta, which have rich alluvial soils. The vast majority of remaining land is covered with infertile rocky or sandy soils that are unsuitable for agriculture.

Climate. Egypt's climate is generally dry. During the summer (May to October), temperatures may reach 42° C (107° F). Winters are generally warm, with average temperatures between 13° and 21° C (55° and 70° F). In the deserts, temperatures range from a mean annual maximum of 46° C (114° F) during the day to a mean annual minimum of 6° C (42° F) after sunset.

The Mediterranean coast receives the most rain, about 200 mm (8 in) or less. In southern Egypt several years may elapse without any rain at all. In April and May hot, dry winds and sandstorms called khamsin blow frequently.

Drainage. The Nile, Egypt's only river, has no tributaries of importance in Egypt; it is navigable as far south as Aswan. The Aswan High Dam created Lake Nasser (now High Dam Lake; Lake Nubia in Sudan), the world's largest artificial lake. The Nile Delta has numerous distributaries, the largest of which are the Rosetta and Damietta. Before regulation by the Aswan High Dam, the Nile flooded its valley every year.

Egypt's best-known oases, located in the Western Desert, include Siwa, Bahariya, Farafra, Dakhla, and Kharga. In the coastal area of the Sinai Peninsula, water drainage toward the Mediterranean supplies sufficient moisture for some agriculture.

Vegetation and Animal Life. Egypt's desert climate restricts most vegetation to the Nile Valley and Delta and the oases. The most widespread indigenous tree is the date

AT A GLANCE

ARAB REPUBLIC OF EGYPT

Land: Area: 1,001,449 km^2 (386,660 mi^2). Capital and largest city: Cairo (1986 pop., 6,052,836).

People: Population (1990 est.): 54,700,000. Density: 54.6 persons per km^2 (141.5 per mi^2). Distribution (1989): 45% urban, 55% rural. Official language: Arabic. Major religions: Islam, Coptic Christianity.

Government: Type: republic. Legislature: People's Assembly. Political subdivisions: 26 governorates.

Economy: GDP (1988): $33.25 billion; $650 per capita. Labor distribution (1986): agriculture—42.7%; mining—0.3%; manufacturing—15.5%; construction—4.7%; public utilities—0.8%; transportation and communications—4.9%; trade—8.5%; finance—1%; public administration, defense, and services—21.6%. Foreign trade (1987): imports—$11.9 billion; exports—$4.4 billion. Currency: 1 Egyptian pound = 100 piastres.

Education and Health: Literacy (1986): 45% of adult population. Universities (1987): 13. Hospital beds (1986): 94,534. Physicians (1984): 73,300. Life expectancy (1989): women—60; men—59. Infant mortality (1989): 93 per 1,000 live births.

palm. The lack of forest and grazing areas limits wild-animal life. Crocodiles are found in the Upper Nile. Egypt has more than 300 species of birds and 100 species of fish.

People

Most Egyptians are descended from the successive Arab settlements that followed the Muslim conquest in the 7th century, mixed with the indigenous pre-Islamic population. The typical Egyptian, of mixed heritage, is the Fellah, or peasant; the fellahin constitute about 50% of the population. Egyptian Copts (see Coptic Church), a Christian minority descended from the pre-Arab population, constitute nearly 7% of the population. The Nubians, who live south of Aswan, have been Arabized in religion and culture. Nomads, who live in the semidesert regions, are composed of both Arab and Berber elements.

Language. Arabic is the official language of Egypt and is spoken by almost all Egyptians. The Coptic language, which is descended from ancient Egyptian, is now used only in the Coptic liturgy. Italian, Greek, and Armenian are heard in Cairo and Alexandria. Berber is spoken in some of the western oases. Many of the nearly 100,000 Nubians in the south speak Sudanic languages (see Afroasiatic languages).

Religion. Nearly 93% of Egyptians are Sunni Muslims (see Sunnites). In addition to Coptic Christians, other religious minorities include Greek Orthodox, Roman Catholics, Armenians, and a very small Jewish community, all concentrated in urban centers.

Demography. Egypt has a high rate of population growth. By the late 1980s, about 40% of its people were under the age of 15. Population density in the Nile Delta, where nearly 99% of all Egyptians live, is one of the highest in the world.

Cairo is the principal industrial and commercial center. Alexandria, the chief port and second largest city, is an important commercial center. Port Said, Tanta, and Giza have long been major urban areas. Other cities such as Aswan and Zagazig have grown gradually with industrial development. Rapid urbanization has taken place over the last several decades.

Education. Because of the rapid population growth over recent decades, governmental efforts to reduce the illiteracy rate are making only slow progress. Education in Egypt is under government control and is free, including university education. Children between the ages of 6 and 12 are required by law to attend elementary school.

Egypt has a large number of institutions of higher learning. Al-Azhar University in Cairo, founded in 970 for Islamic learning, is one of the oldest universities in the world. Ain Shams University (1950) and Cairo University (1908) are Egypt's largest.

Health. Egypt's medical system, which is under governmental control, provides free medical care. Bilharzia, an energy-sapping disease caused by small worms in the Nile's waters, afflicts about half of the population. Intestinal and respiratory diseases are common, although significant improvements in public health and medical facilities since 1952 have substantially increased life expectancy.

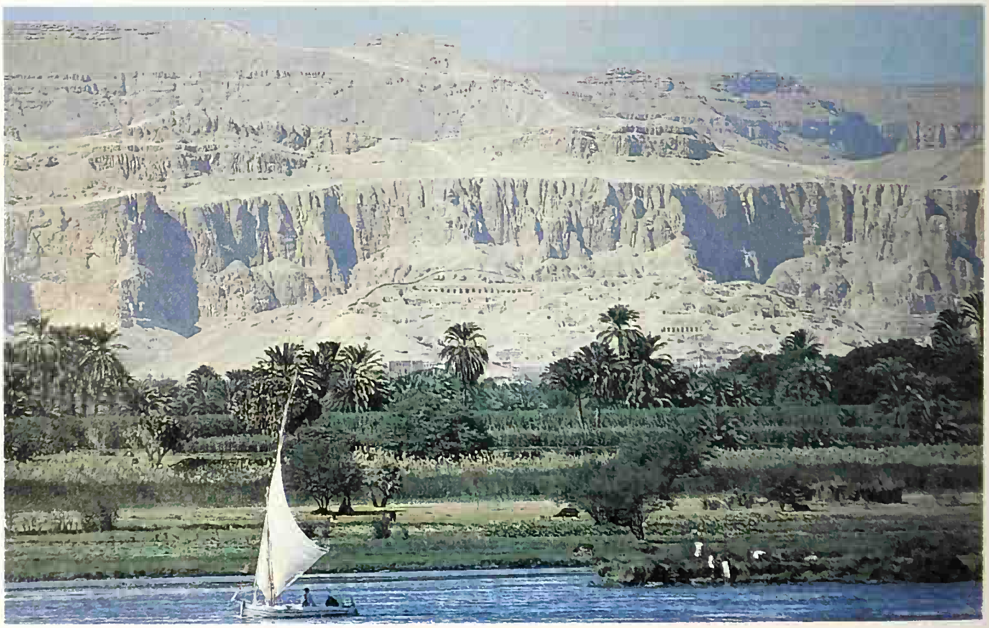
The Arts. Culture in ancient Egypt influenced the Hebrew and Greek civilizations. Following the Arab conquest of Egypt, the arts once again flourished. Public buildings and palaces during the FATIMID caliphate (969–1171) were characterized by elegant architecture (see ISLAMIC ART AND ARCHITECTURE). After the French invasion of Egypt in 1798, JAMAL AL-DIN AL-AFGHANI, Muhammad Abduh (1849–1905), and other writers attempted to relate divine revelation to reason in order to resolve the conflict between modern and traditional values. Muhammad Husayn Haykal (1888–1956) was the author of one of the earliest novels in modern Arabic, *Zynab* (1914). One of the first writers to be recognized outside of the Middle East was the prolific TAHA HUSAYN. The novelist and playwright Tawfiq al-HAKIM was a satirist and social critic. Other prominent 20th-century Egyptian writers include the dramatist Mahmud Taymur; the novelists Naguib MAHFOUZ, the 1988 Nobelist for literature, and Yusuf Idris; and the poet Abbas al-Aqqad. (See also ARABIC LITERATURE.)

Since the late 1920s, Egypt has been the principal Arab filmmaking center. The government actively encourages drama and owns all theaters. Traditional music, especially when adapted to Western rhythm, is very popular. The Cairo Symphony is Egypt's outstanding national orchestra.

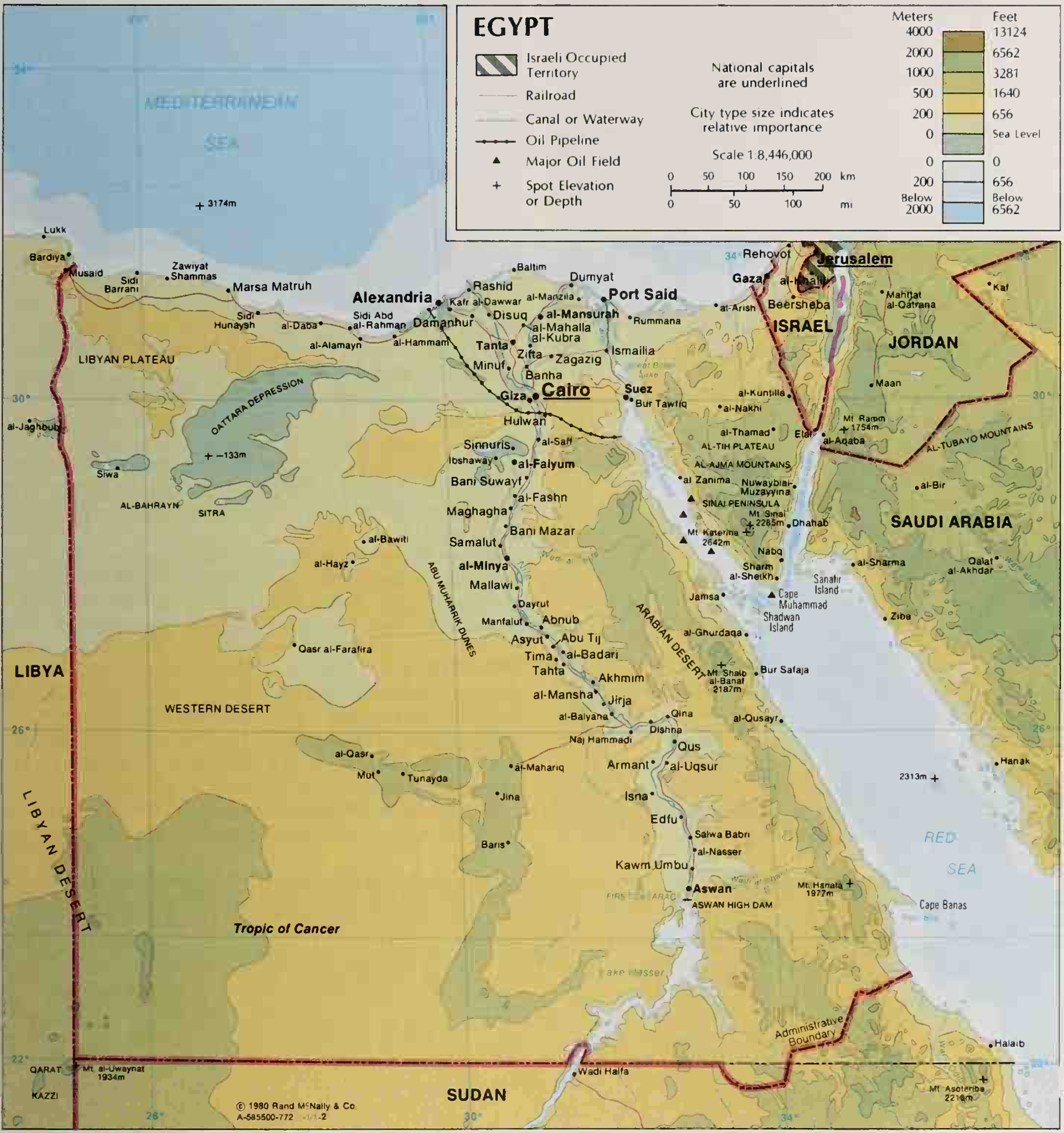
Economic Activity

Prior to the 1952 Socialist revolution that overthrew the monarchy, the Egyptian economy was based primarily on farming, and there was little industrial activity. After 1952 the economy started to expand gradually through a series of government programs. Economic expansion has failed to keep pace with population growth, however, and Egypt faces serious economic problems characteristic of developing countries. Investment funds and national resources (particularly arable land) are limited, and the country is heavily dependent on foreign aid. In the 1980s, a rise in Middle East tensions and a world oil glut reduced the chief sources of foreign exchange: tourism, remittances from overseas workers, Suez Canal revenues, and petroleum exports. Further strains were caused by the expulsion of thousands of Egyptian workers from Iraqi-occupied Ku-

Cairo, Egypt's capital, contains hundreds of mosques and other Islamic sites. This view of the medieval city was taken from the Ibn Tulun Mosque (876–79), the second oldest in Cairo.



A felucca plies the Nile River. In the background is the Valley of the Queens, with tombs dating back to ancient Egypt's New Kingdom (1570–1085 BC).



wait in 1990 and the subsequent GULF WAR.

Manufacturing and Industry. The textile industry has long been the principal manufacturing activity. Other important products include cement, iron and steel, chemicals, fertilizers, rubber products, refined sugar, tobacco, canned foods, cottonseed oil, small metal products, shoes, and furniture.

Mining and Energy. Mining has increased in importance since the mid-1970s. Crude petroleum is the leading product, but salt, phosphate, iron ore, and manganese are also extracted. The availability of sufficient power remains a basic problem. Egypt is self-sufficient in petroleum and has some coal and natural-gas deposits. Much of its electric power is provided by the Aswan High Dam.

Agriculture. Agriculture, which contributes about one-third of the gross domestic product, is labor-intensive, using traditional methods. Per-hectare yields are among the highest in the world, although a rise in the water table and soil salinity caused by the Aswan High Dam have decreased yields in the Nile Delta. Land-reform laws limit individual holdings to about 40 ha (100 acres), but there are widespread evasions of the law. The pressure on the scarce arable land has steadily increased due to population growth, and costly government land-reclamation and irrigation projects have been offset by the loss of cultivable land to urban sprawl.

Egypt, once self-sufficient in food, today imports nearly one-half of its foodstuffs. Attempts to reduce costly government subsidies on foods and other basic commodities have provoked violent urban unrest. Egypt is one of the largest cotton exporters in the world. Corn, sugarcane, wheat, rice, barley, millet, onions, and potatoes are grown, as are vegetables, mangoes, citrus fruits, figs, dates, and grapes.

Fishing. Egypt has a flourishing fishing industry. The Aswan High Dam adversely affected fishing along the Mediterranean coast; today about 70% of the total catch is obtained from inland waters, including fisheries along Lake Nasser.

Transportation. The Nile River and the SUEZ CANAL are both important transportation arteries. The railroad system (begun 1851) is government controlled. The chief ports are at Alexandria, Port Said, and Suez. Egyptair, the government-owned airline, has domestic and international flights.

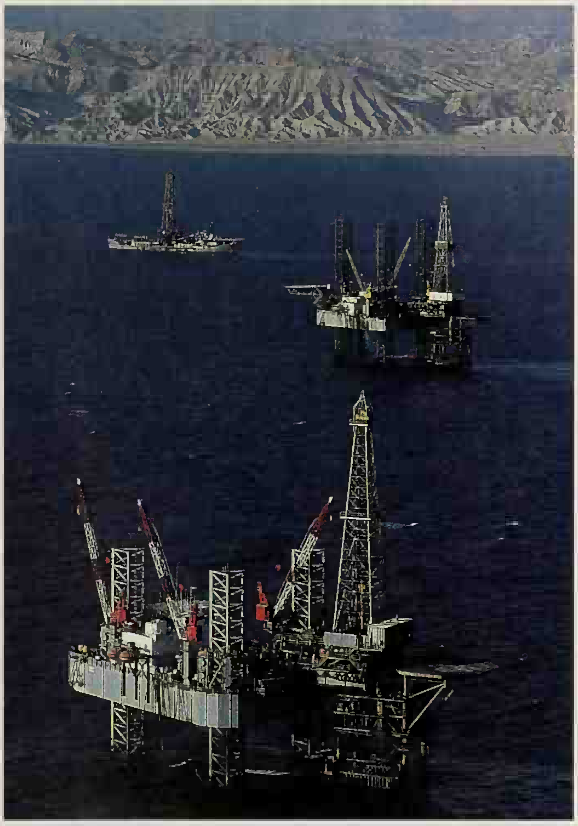
Trade. Petroleum is Egypt's leading export in terms of value, followed by cotton and cotton products. Foodstuffs, machinery, and transportation equipment are the major imports. For many years Egypt has had a trade deficit.

Government

The constitution, adopted in 1971, defines Egypt as "an Arab Republic with a democratic, socialist system." Executive power is vested in the president, who is nominated by at least two-thirds of the legislature and then elected for a 6-year term by popular referendum. The president may appoint vice-presidents and the cabinet and can dismiss them and dissolve the legislature at any time.

(Above) *Egypt's population growth has caused a severe housing crisis in Cairo, the largest city in Africa.*

(Right) *Herders bring their livestock to an animal market in Luxor. The site of ancient Thebes, Luxor is also visited by hundreds of thousands of tourists annually.*



(Above) *An Egyptian woman tends a carding machine in a wool-processing factory in the Nile Delta region. Textiles, particularly cotton, are Egypt's principal manufacture.* (Right) *Oil rigs off the shore of the Sinai Peninsula extract petroleum from below the waters of the Gulf of Suez.*

The unicameral National Assembly functions primarily as a policy-approving body. Although the legal system is generally based on Islamic law, efforts by fundamentalists to impose a strict Islamic code have been unsuccessful. For administrative purposes, Egypt is divided into 26 governorates. Each is headed by a governor appointed by the president. The leading political party is the National Democratic party (NDP), which gained 70% of the vote in the 1987 legislative elections. New elections held in November 1990 after a court ruled the 1987 election unconstitutional were boycotted by opposition groups.

History

For the history of Egypt prior to the 7th century AD, see EGYPT, ANCIENT.

Arab Conquest. Between AD 639 and 642 the Arabs took control over Egypt from the Byzantine Empire and introduced both the Arabic language and Islam. The Arab CALIPHATE had its capital at Damascus under the Umayyads and at Baghdad under the Abbasids. In 969, however, the Fatimids, a Shiite dynasty, conquered Egypt and founded Cairo as its capital. Fatimid rule ended in 1171 when SALADIN conquered Egypt and united it with Syria. He founded the Ayyubid dynasty (1171–1250) and restored Egypt to Sunni Islam. The Ayyubid dynasty, weakened by the Fifth and Sixth Crusades, was brought to an end when the MAMELUKES, originally brought to Egypt as war captives, revolted against their masters and seized power in 1250. Under their rule Egypt became an important cultural, military, and economic center. In 1517, Cairo was conquered by the Ottoman sultan Selim I, who reduced the role of Egypt to that of an exploited province of the OTTOMAN EMPIRE.

European Influence. Ottoman rule of Egypt remained uninterrupted until 1798, when a French army under Napoléon Bonaparte (NAPOLEON I) arrived in Egypt. Although the French were expelled in 1801, their short occupation brought the country into close contact with the West.

During a power struggle that followed the expulsion of the French, MUHAMMAD ALI PASHA, an Albanian officer in the Ottoman forces, established himself in a position of power and was recognized (1805) as viceroy of Egypt by the Ottoman sultan. In 1811 he rid Egypt of the Mamelukes. He undertook (1811–18) successful military campaigns in Arabia and conquered (1820–22) the Northern Sudan. In 1824 he sent an Egyptian force, led by his son Ibrahim, to help the Ottoman sultan suppress the Greek independence revolt, but the Egyptian and Turkish fleets were destroyed at the Battle of Navarino. When the sultan rejected Muhammad Ali's demand for Syria in recompense, Ibrahim conquered (1831) Syria and ruled it for seven years. War with the Ottomans broke out, and in 1841, Muhammad Ali defeated the Ottoman sultan and became hereditary ruler of Egypt. During his rule, Muhammad Ali embarked upon programs of reform and modernization that laid the foundations of modern Egypt.

The Modern Era. Under Muhammad Ali's hereditary successors, Egypt's prosperity declined, despite the construction of the Suez Canal (opened 1869) with the help of a French firm. Khedive ISMAIL PASHA borrowed increasingly large sums of money from Europeans, sold (1875)

Muhammad Ali Pasha, an Albanian officer in the Ottoman army, was made viceroy of Egypt in 1805. Under his leadership, agriculture, education, and the military were modernized. In 1841, Muhammad Ali secured Egypt's independence from Ottoman rule.

most of Egypt's shares in the Suez Canal to Great Britain, and was forced (1876) to accept the establishment of a joint Anglo-French debt commission. In 1879, Ismail was deposed in favor of his son Tawfiq Pasha. A nationalist revolt in 1881–82 was suppressed by the British, who then became the controlling power in Egypt. From 1883 to 1907 the effective ruler of the country was the British administrator Lord Cromer (see Cromer, Evelyn Baring, 1st Earl of). When World War I began in 1914, Britain made Egypt a protectorate and used it as a base for Allied operations against the Ottoman Empire. In 1922 the protectorate was ended, and Egypt became a monarchy with Fuad I as king. In 1937 he was succeeded by King Farouk, and British troops withdrew from Egypt, except in the Suez Canal Zone.

During World War II, Egyptian forces helped the British to defeat the Germans at El Alamein. After the war, national feelings grew stronger, and discontent increased after Arab armies were defeated in the 1948 Arab-Israeli war. In 1952 the Egyptian army seized power, and King Farouk abdicated. The monarchy was abolished in 1953, and Egypt became a republic with Gen. Muhammad Naguib as the first president. In 1954, Col. Gamal Abdel Nasser forced Naguib out of office and became president. When Nasser nationalized the Suez Canal in 1956, Britain, France, and Israel invaded Egypt. The troops were forced to withdraw under international pressure (see Suez Crisis). Nasser's successful resistance to the triple aggression increased his popularity in the Arab world and led to Egypt's forming a short-lived union (1958–61) with Syria as the United Arab Republic.

In 1967 increased tension between Israel and the Arab states and the closure of the Gulf of Aqaba to Israeli shipping brought about war with Israel. During the so-called Six-Day War the Israeli air force attacked and destroyed the Egyptian air force on the ground, and the Egyptian army was defeated in the Sinai, which came under Israeli occupation.

Nasser died in September 1970 and was succeeded by his vice-president, Anwar al-Sadat. In July 1972, Sadat ordered the 20,000 Soviet military advisors and experts in Egypt to leave because he believed that the Soviets were not willing to supply Egypt with weapons needed to liberate the territory lost to Israel. Domestic unrest contributed to the launching of a surprise attack on Oct. 6, 1973. Egyptian forces crossed the Suez Canal into the Sinai, and Syrian forces entered the Golan Heights. Egypt regained a strip of the Sinai during the three-week war. The war, along with the reopening of the Suez Canal in June 1975, enhanced Sadat's reputation.

The Peace Initiative. In 1974 the United States and Egypt resumed diplomatic relations, previously severed by Egypt in 1967. By September 1975, through U.S. mediating efforts, Egypt and Israel had reached several agreements on the disengagement of their forces. Sadat took a dramatic step toward peace with Israel by visiting Jerusalem in November 1977. President Jimmy Carter sponsored (September 1978) a peace summit at Camp David, Md., between Sadat and Israeli prime minister Menachem Begin. It led to the signing of an Egyptian-Israeli peace treaty on Mar. 26, 1979, in Washington, D.C.. The gradual withdrawal of Israeli troops from the Sinai over a period of three years proceeded smoothly, and in January 1980, Egypt and Israel established diplomatic relations. Little progress was made, however, in the difficult negotiations on Palestinian autonomy, and the rest of the Arab world rejected the rapprochement with Israel.

Although Sadat increased political freedoms, he also periodically cracked down on dissidents. In 1981 he was killed by Muslim fundamentalists. His successor, Hosni Mubarak, honored the peace treaty with Israel but criticized the lack of progress on the Palestinian issue. He improved Egypt's ties with other Arab nations, gaining readmission to the Islamic Conference Organization in 1984 and to the Arab League in 1989, and won a second term as president in 1987. His activist foreign policy improved his domestic standing and won him the gratitude of the United States. Egypt had aided Iraq in the Iran-Iraq

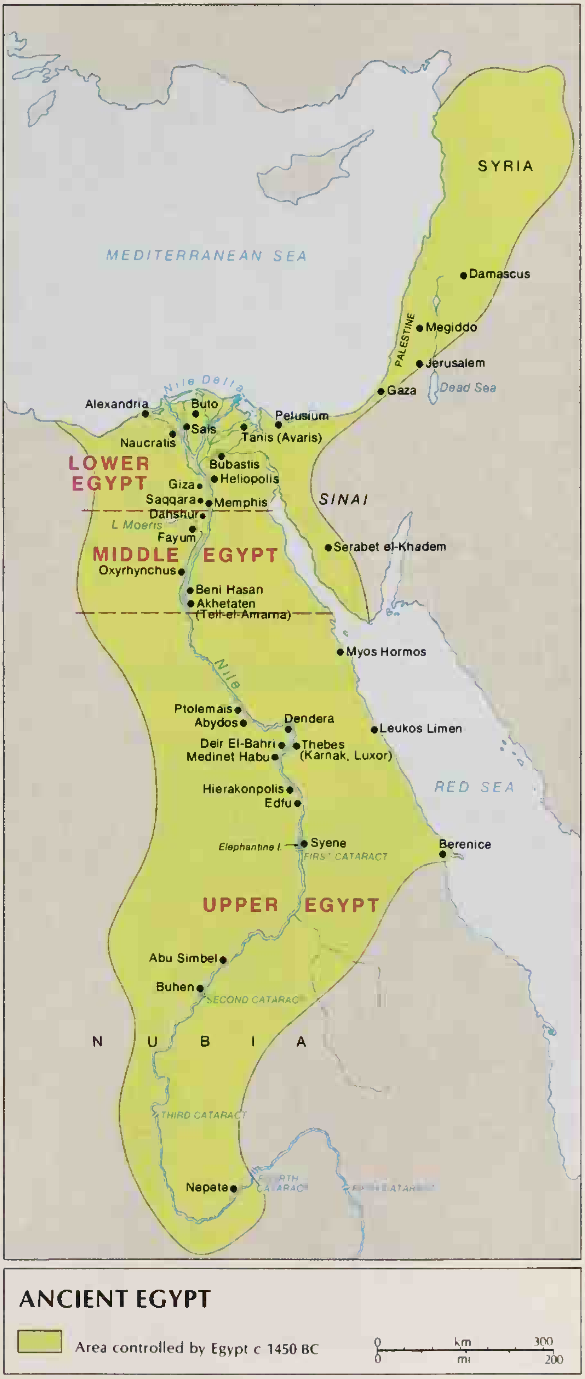
A fatherly depiction of Gamal Abdel Nasser, Egypt's former leader, is shown in this poster. Nasser, who became president in 1954, emerged as a charismatic leader of Arab nationalism.

The pyramids of Giza were built as tombs for Egypt's pharaohs and are ranked among the technological wonders of the world. Like many of Egypt's historic monuments, they are being threatened by urban sprawl and industrial pollution.

WAR (1980–88). After Iraq invaded Kuwait in August 1990, however, Mubarak convened the Arab summit that voted to deploy Arab soldiers to supplement U.S. forces invited to Saudi Arabia, arguing that no Arab state should attack and occupy another; Egyptian ground forces were part of the multinational Gulf war coalition. Perhaps his greatest energy was expended in supporting the U.S. effort to persuade Israel to implement an Egyptian plan for autonomy for the Palestinians in the Israeli-occupied West Bank and Gaza Strip. In the process, Egypt resumed its historical role as the leader of Middle Eastern diplomacy.

Egypt, ancient The civilization of ancient Egypt, together with those of Mesopotamia, India, and China, was one of the earliest in the world. It is perhaps the best example of continuous cultural evolution based on internal stimuli. Egyptian influence on other peoples was considerable. Syria-Palestine was strongly affected by Egyptian religion and art, and the cults of some Egyptian gods had followers in both Greece and Rome. The western alphabet is derived from the Phoenician, which was possibly modeled on Egyptian HIEROGLYPHICS. Egyptian ideas are found in some parts of the Bible; and Greek science and art were originally inspired by Egypt's. Its rich monuments and inscriptions, studied by archaeologists since the early 19th century, have made Egypt and EGYPTOLOGY subjects of continuing interest.

Nowhere has environment more strongly affected a nation's history. In a largely rainless climate, Egypt's high agricultural productivity depended on a long but very narrow floodplain—the gift of the Nile, as Herodotus called it; on average 19.2 km (11.9 mi) wide, it reached a maximum of 248 km (154.1 mi) in the Delta and was formed by the Nile's annual inundation. Periodic, long-term decreases in its volume might create social stress and political and military conflict; increases in volume increased food supplies and favored stability and centralized government. The deserts to the east and west had valuable stones and minerals and helped protect Egypt from external attack or infiltration. To the south and northeast, however, important kingdoms developed. Egypt traded with and exploited these kingdoms but was sometimes



Cartographic Production by Lothar Roth & Associates

(Right) *Agricultural production was the economic foundation of ancient Egypt. These daily farming scenes from a Theban tomb (c.400 BC) depict the breaking of earth clods and sowing by hand. Wheat and barley were staple products. Successful cultivation of the arid land was insured by the annual flooding of the Nile and an advanced irrigation system.*

(Below) *This tomb painting of the 18th dynasty depicts a banquet scene with musicians and a dancer. (British Museum, London.)*

threatened by them. Beyond Syria-Palestine, greater powers—in Anatolia, Mesopotamia, and Iran—were alternately allies or rivals in imperial expansion.

Achievement, continuity, and innovation characterized Egyptian civilization. Major achievements included a continuous drive toward political unity and social stability; the creation of a surplus in food and materials that supported a superstructure of administrators, soldiers, priests, and craftsmen; and the invention or adoption of a writing system (*c.*3100 BC). Literacy made government more effective; it also stabilized and enriched religion and science. In turn, these achievements promoted the growth of an elaborate and often colossal architecture, and the development of highly accomplished art forms, which were among the most distinctive in the ancient world.

Egypt's religion (see MYTHOLOGY), its concept of social order, and its system of strong monarchical government remained fundamentally unchanged for over 3,000 years. Environmental stability helped, as did ethnic and linguistic homogeneity. Equally important was a powerful and tenacious worldview shared by all Egyptians: belief in an orderly cosmos, enfolding gods, humans, and nature, that had been created in complete and perfect form at the beginning of time. Adherence to traditional forms of belief, government, and culture was thought necessary to maintain perfection and to prevent the collapse of the universe. Egyptian art and religious architecture closely followed established conventions of style and content because their role was to depict this ideal order—and thus to ritually integrate Egypt with the cosmos.

Change and innovation nevertheless occurred. Egypt's interludes of disunity were politically disorderly and economically painful because inherent problems and contradictions came to the surface and demanded solutions. Less obviously, change also took place in more stable times. Bureaucracies were periodically reformed or restructured in the interests of both royal power and fairer government. Religious concepts became increasingly rich and complex. and styles in art and architecture changed subtly to meet new needs.

Predynastic Egypt. Egyptian history is usually divided into periods roughly corresponding to the 30 dynasties of kings listed by Manetho, an Egyptian chronicler of the 3d century BC. The period before *c.*3100 BC, a time for which no written records exist, is called the Predynastic era.

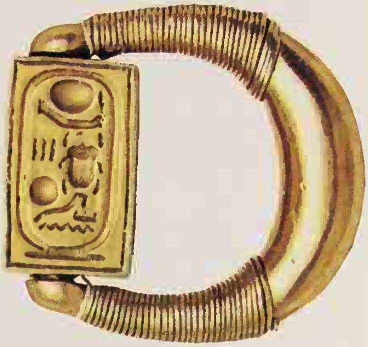
Well before 5000 BC many communities of Paleolithic hunters and gatherers lived in the Nile valley and across savanna lands stretching far to the east and west. As rainfall decreased, especially after 4000 BC, the western lands became arid deserts and human settlement was confined to the valley and its fringes. Here exotic fauna such as elephants and giraffes persisted as late as 2300 BC before retreating southward.

Annually inundated, and with natural irrigation basins that retained floodwaters, the Nile valley was an ideal setting for Mesolithic economies to evolve into Neolithic ones based on sedentary agriculture. In northern Egypt the development of Neolithic life can be traced at Merimdeh and in the Fayum (5000–4000 BC). The earliest Neolithic phases of southern Egypt are not yet identified, but two cultures existed there by *c.*4000 BC: the Tasian, influenced by the north, and the Badarian, which originated in the eastern desert.

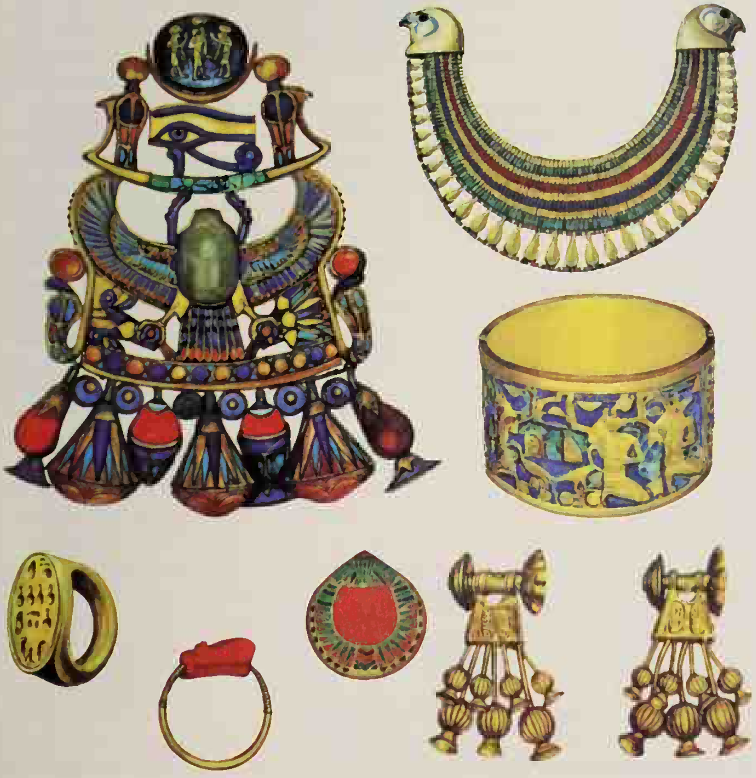
Supported by an agricultural surplus, political elites developed, partly through their control over valuable resources, like copper and precious metals, that were beginning to be used in new technologies. Larger, more efficient river ships were built and trade along the Nile expanded. By late Predynastic times (*c.*3300 BC) the various chiefdoms had coalesced into two competitive kingdoms, one in the north and the other in the south, of which the southern gradually became dominant.

Throughout the period 5000–3100 BC, foreign influences were significant. Both northern and southern Egypt traded with Syria, Palestine, and northeast Africa throughout Predynastic times. Mesopotamian influences can be seen in the cylinder seals, pottery, and artistic motifs of southern Egypt, though these may have come through intermediaries.

Predynastic architecture is best attested in cemeteries, where pit graves were lined with wood or brick and roofed with matting or stone slabs; eventually, some graves had small, solid superstructures of brick and rubble. A possible Predynastic temple was recently found at HIERAKONPOLIS. Art was well developed but small in scale and included figurines and statuettes of individual humans or animals, slate cosmetic palettes, and painted designs on pottery. Most of these art forms were from tombs and were magical or religious representations. In later Predynastic times ivory knife handles and ceremonial palettes bore scenes in relief. Battles, hunts, and ceremonial scenes were favorite motifs.



(Above) *This royal seal was the possession of the pharaoh Horemheb and dates from the beginning of the 19th dynasty (1320–1200 BC). The scarabus beetle, a symbol of rebirth and immortality in Egyptian mythology, is incorporated in the cartouche of Horemheb.*



(Left) *Egyptian artisans excelled in the decorative art of jewelry making, using gold, silver, and semiprecious stones. This collection of jewelry illustrates the diverse styles in pectorals, bracelets, rings, pendants, and earrings.*

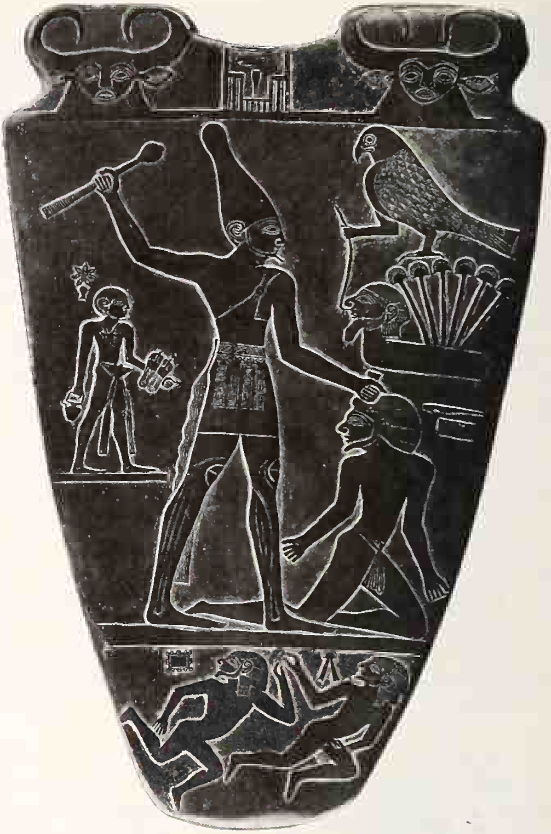
Early Dynastic Period and Old Kingdom. The two kingdoms were apparently unified by King Narmer (later called Menes or Meni, "the founder"); a ceremonial slate palette shows him surveying slaughtered prisoners, striking a northern enemy, and wearing the regalia of both kingdoms. He and his immediate predecessors were buried at Abydos, at or near the southern capital. Narmer's successors were the pharaohs of the 1st and 2d dynasties, who made Memphis in the north the new capital of united Egypt, and were buried in tombs at nearby Saqqara.

Royal power had greatly increased by the 3d dynasty (*c.*2686–2613 BC), when much larger royal tombs, now dominated by step pyramids in stone, were built at Saqqara. The best preserved is Zoser's; the pyramid was 62 m (190 ft) high and surrounded by a complex of buildings, representing both a funerary cult place and eternal palace, the whole protected by a towered stone wall. Even more dramatic were the pyramids of the 4th dynasty at Giza and elsewhere. Khufu's (Cheops's) Giza pyramid, the largest ever, has a volume of 2.59 million m^3 (91.46 million ft^3). Pyramids of the 5th and 6th dynasties at Abusir and Saqqara were smaller but still impressive.

DYNASTIES OF ANCIENT EGYPT*

Predynastic Period	*c.*5000–3100 BC
Early Dynastic Period	*c.*3100–2686 BC
1st dynasty	*c.*3100–2890 BC
2d dynasty	*c.*2890–2686 BC
Old Kingdom	*c.*2686–2181 BC
3d dynasty	*c.*2686–2613 BC
4th dynasty	*c.*2613–2494 BC
5th dynasty	*c.*2494–2345 BC
6th dynasty	*c.*2345–2181 BC
First Intermediate Period	*c.*2181–2040 BC
7th dynasty	*c.*2181–2173 BC
8th dynasty	*c.*2173–2160 BC
9th dynasty	*c.*2160–2130 BC
10th dynasty	*c.*2130–2040 BC
11th dynasty	*c.*2133–2040 BC
Middle Kingdom	*c.*2040–1786 BC
11th dynasty	*c.*2040–1991 BC
12th dynasty	*c.*1991–1786 BC
Second Intermediate Period	*c.*1786–1567 BC
13th dynasty	*c.*1786–1633 BC
14th dynasty	1786–*c.*1603 BC
15th dynasty	1674–1567 BC
16th dynasty	1684–1567 BC
17th dynasty	*c.*1650–1567 BC
New Kingdom	*c.*1570–1085 BC
18th dynasty	1570–1320 BC
19th dynasty	1320–1200 BC
20th dynasty	1200–1085 BC
Late Dynastic Period	1085–332 BC
21st dynasty	1085–945 BC
22d dynasty	945–*c.*730 BC
23d dynasty	*c.*817–730 BC
24th dynasty	720–714 BC
25th dynasty	716–656 BC
26th dynasty	664–525 BC
27th dynasty	525–404 BC
28th dynasty	404–399 BC
29th dynasty	399–380 BC
30th dynasty	380–341 BC
31st dynasty	341–332 BC
Alexander the Great	333–323 BC
Ptolemaic Dynasty	323–30 BC

*Exact dating of the Egyptian dynasties is impossible; the chronology shown here is one of several used by historians.



The Narmer Palette, a slate plaque commemorating King Narmer's (or Menes's) unification of Upper and Lower Egypt, is one of the earliest extant historical records. This side of the palette shows Narmer striking down an enemy.

In its totality, the pyramid complex both served the dead king and linked kingship and cosmos together. The complex consisted of a temple and imitation palace, with the pyramid a means of ascent; scenes within the complex, however, depicted the king's role in the cosmos as overthrower of chaos, and the pyramid also represented the primeval mound upon which the creation of the universe had taken place. During the 5th dynasty, temples of the sun god Ra (Re), the creator and maintainer of the universe, were built near pyramids, reflecting the unique relationship between sun god and king; the latter was called "son of Ra" from the 6th dynasty on.

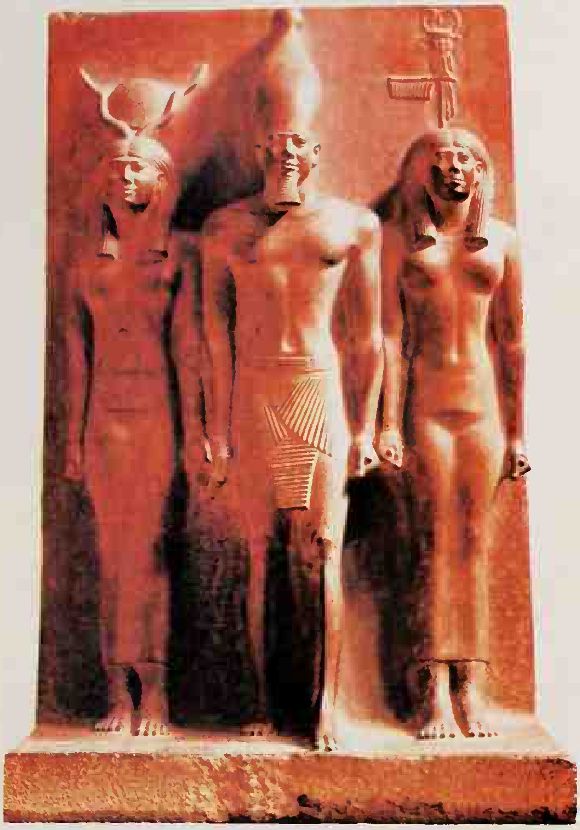
The materials, organization, and labor required by the pyramids, and the many estates supporting the cult and personnel of each, clearly reveal the king's firm control over Egypt and its resources. This was achieved through a complex government, consisting of a central bureaucracy, directly under the pharaoh's supervision, and more than 30 provincial bureaucracies reporting to the center. Periodically kings restructured aspects of the system; royal sons were first used, then excluded to avoid rivalries; high central officials were reduced in power if they threatened royal control, but restrengthened if the lower ranks and provinces became too independent. Throughout the Old Kingdom, revenues were collected, labor and resources exploited, and justice and arbitration provided; literary works extolling the bureaucracy and advising on proper behavior were popular.

Egypt's internal strength encouraged expansion and aggression abroad. In the Early Dynastic period the Egyptians already had extensive trade contacts with Syria, Palestine, and northeast Africa; they now pushed into the Sinai and northern Nubia, creating buffer zones and Egyptian-dominated trade routes. Later, in the 4th and 5th dynasties, Egyptian armies raided Palestine and southern Nubia; by the 6th dynasty, however, stronger regional kingdoms in these areas put Egypt on the defensive.

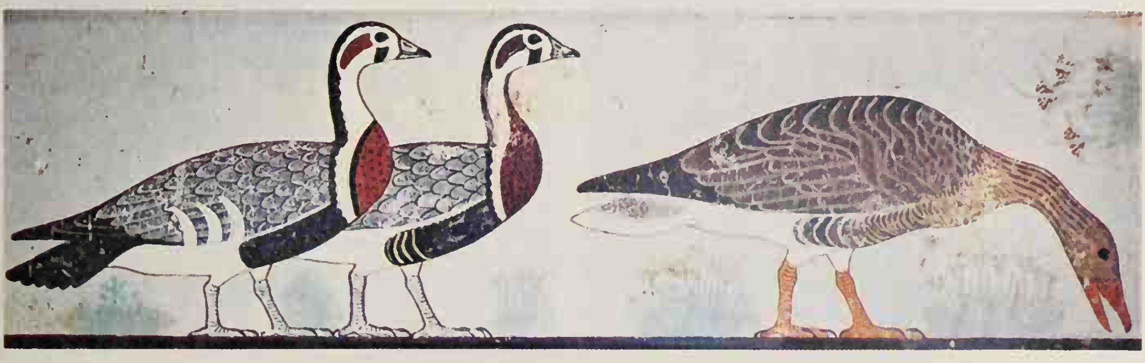
Initially, the royal court with its adjacent cemeteries was the major center of intellectual, artistic, and architectural activity, but as towns began to develop in various parts of Egypt, they too shared in the cultural life of the time. Royal relatives and central officials were buried under MASTABAS, rectangular superstructures of brick or stone. The mastabas contained chapels and other rooms, which, increasing in number over time, opened up more wall space to be covered with reliefs and paintings. These depicted the funerary cult and also scenes showing the preparation of a multitude of foods, liquids, and objects for the benefit of the deceased.

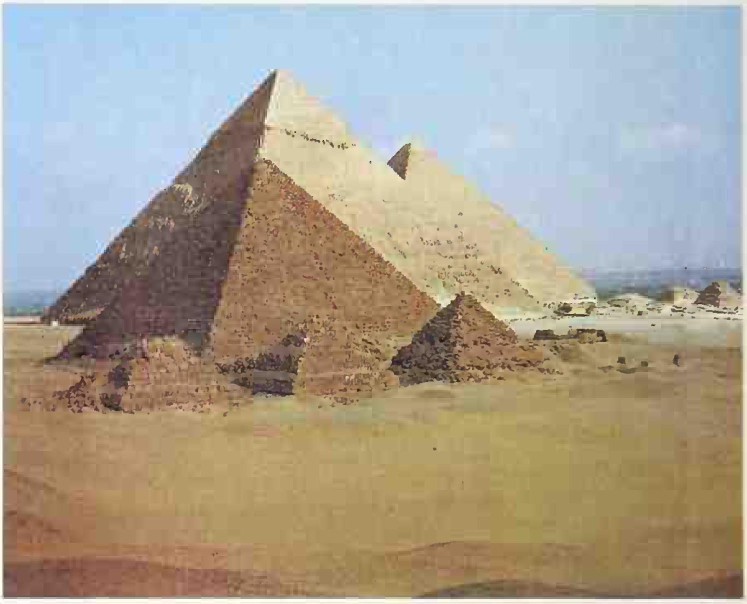
Such art, appearing realistic, actually followed conventions that were to remain dominant for millennia. In painting and relief, human and animal figures were always drawn according to fixed proportions, with reality subordinated to a presentation of the most characteristic aspects. Humans, for example, are always shown with their heads, legs, and feet in profile but with their eyes and torsos presented frontally. Figures were scaled according to their importance, and perspective ignored. Landscapes were depicted in schematic form, but architecture was rarely attempted. An idealized world is shown, from which aging, disease, injury, and death are omitted, except in the case of inferior beings such as foreigners and animals.

Statuary was intended mainly for temples and tombs, and consisted of representations of gods, kings, and de-



(Above) *This slate statue of the 4th dynasty depicts King Menkaure, protected by the goddess Hathor and a local deity. The rigid frontal posture is characteristic of the sculptural work of the Old Kingdom. (Egyptian Museum, Cairo.)* (Below) *Rhythm and movement pervade this mural of painted geese from the tomb of Atet in Meydum. Dating from the beginning of the 4th dynasty, this tomb is one of the first with scenes assimilating realistic details of daily life. (Egyptian Museum, Cairo.)*





(Above) *This limestone statue from Saqqara represents a scribe of the Old Kingdom. The scribes, official keepers of records, were indispensable to the royal government.* (Right) *The pyramids of Giza are the tombs of the Old Kingdom monarchs Khufu, Khafre, and Menkaure.*

ceased individuals. Complex compositions were avoided. Life-size statues were not uncommon, but most were smaller; colossal royal figures embellished temples. As in painting, set conventions were closely followed in statuary; figures always face forward, with arms and legs in standardized positions. Materials included hard stones, limestone, and wood, and the statues were often painted in bright colors. Sculptors depicted the ideal human; true portraiture in any form was hardly ever attempted.

First Intermediate Period and Middle Kingdom. Centralized rule began to break down under the 7th dynasty. In the ensuing First Intermediate period (*c.*2181–2040 BC), the Memphite monarchs were powerless to prevent provincial warlords from fighting each other over territory. Eventually two separate kingdoms emerged, one ruled by the 9th and 10th dynasties from Heracleopolis, the other by the 11th dynasty from THEBES. They tried to dominate each other but were impeded by the semi-independent provincial rulers. Finally, in the 20th century BC, Nebhepetre Mentuhotep of the 11th dynasty conquered the north and rebuilt a centralized monarchy, inaugurating the Middle Kingdom.

The 12th dynasty, founded (1991 BC) by Amenemhet I, worked hard to restore royal prestige, which had been seriously damaged by civil war and periodic famine. Its kings, living near Memphis, reduced provincial power and developed a loyal central elite. Propaganda transformed the royal image from insecure war leader to confident, semidivine ruler. The external situation remained dangerous. The northern Nubian and Sinai buffer zones were reoccupied and, for the first time, heavily fortified. Foreign trade and diplomatic contact expanded, but Egyptian activity was more restricted than it had been in the Old Kingdom.

Social change was considerable. People had become more conscious of their individual rights, and royal policy had to both satisfy and temper this. Religion was affected: funerary beliefs and rituals once largely restricted to kings now spread throughout all classes; OSIRIS, formerly a royal funerary god, became accessible to all. First Intermediate period Egyptians had felt less dependent economically on the state, and even under the 12th dynasty royal policies encouraged the growth of a middle class.

The pharaoh Akhenaten (r. 1379–1362 BC) carried the power of Egyptian kingship to its highest point. Known as history's first monotheist, he tried to abolish Egypt's traditional religion and replace it with the worship of the Aten (sun-disk), of which he was the earthly manifestation.

This painted limestone portrait bust of Queen Nefertiti, the consort of Pharaoh Akhenaten, is from the Amarna period of the New Kingdom. (State Museums, Berlin-Dahlem.)

Architecture became more varied. At Kahun, a large town was divided into zones of better and poorer houses, reflecting socioeconomic differences; superbly designed fortresses were built in Nubia; and royal cenotaphs (dummy tombs) containing many private memorial chapels of a unique type were constructed at Abydos.

At Thebes a new type of royal tomb developed, culminating in the unique terraced monument of Nebhepetre, topped not by a pyramid but by a cubical version of the primeval mound. Pharaohs of the 12th dynasty, anxious to be identified with the autocratic Old Kingdom, revived the classic pyramid complex but included unusual subterranean elements evoking the mythical tomb of Osiris. Royal statues were often idealized, but some depicted a careworn, more realistic figure.

Second Intermediate Period. Decline and invasion marked the Second Intermediate period (1786–1567 BC). High officials became so powerful in the 13th dynasty that they manipulated and fought over the royal succession. Much shorter reigns imply depositions, assassinations, and possible short-term "elections" of kings. As a result, Egypt's military presence in the vital buffer zones weakened and invasions occurred.

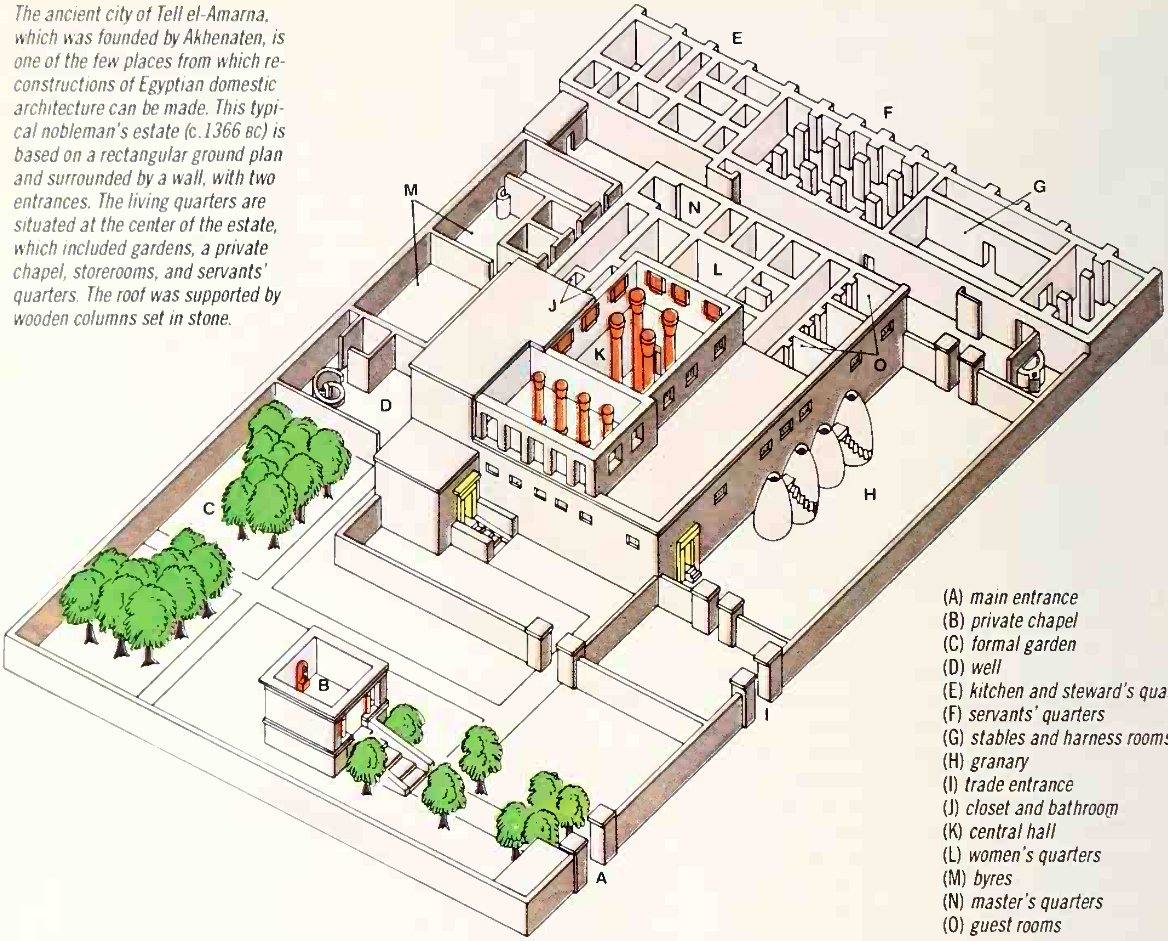
The Cushites of Upper Nubia occupied Lower Nubia, while Syro-Palestinians conquered Egypt itself and established the 15th dynasty. These HYKSOS (from the Egyptian for "ruler of a foreign land") exploited Egyptian ideology but remained Syro-Palestinian in culture. Eventually, Theban vassals (17th dynasty) began a war of independence against an alliance of Hyksos and Cushites.

New Kingdom. Expelling the Hyksos, the Theban insurgents founded the 18th dynasty, inaugurating ancient Egypt's most brilliant period, the New Kingdom (1570–1085 BC). Its rulers included HATSHEPSUT, THUTMOSE III, AKHENATEN, SETI I, and RAMSES II. Under their leadership Egypt expanded to its greatest extent. The early rulers of the 18th dynasty reconquered southern Nubia and Palestine. Thutmose III (*c.*1504–1450) tried to wrest domination of Syria from Mitanni, a north Mesopotamian power, but failed. Thutmose did set up efficient imperial governance, with viceroys controlling foreign vassals who paid rich tribute and sent their successors to be raised in Egypt. International relations were widespread. Babylonia, Assyria, the Hittites, and the Mycenaeans had strong diplomatic and commercial links with Egypt.

Internally, the pattern of royal succession was deviant for a while. Hatshepsut, regent for her young nephew Thutmose III, declared herself pharaoh and ruled for 22 years. Female pharaohs were very rare, and Thutmose resentfully destroyed her monuments after her death. More significant was the transformation of the earlier system of Hyksos vassals into a centralized autocracy. The kings' large armies, generated by foreign wars, cowed internal rivals and set up a streamlined bureaucracy, with a chief minister over each half of the country. All appointments were made directly by the kings, who made frequent tours of inspection.

A special feature of this period was the increasingly wealthy priesthoods, on which the king lavished estates, personnel, and gifts; they eventually owned one-third of Egypt's arable land. They could not easily rival the king, however, for they were his appointees. Moreover, pharaoh

A wall painting from the tomb of Ramses I shows him between the underworld deities Horus (left) *and Anubis* (right). *One of the most important rituals of Egyptian religion was the pharaoh's preparation for the afterlife.*



The ancient city of Tell el-Amarna, which was founded by Akhenaten, is one of the few places from which reconstructions of Egyptian domestic architecture can be made. This typical nobleman's estate (c.1366 BC) is based on a rectangular ground plan and surrounded by a wall, with two entrances. The living quarters are situated at the center of the estate, which included gardens, a private chapel, storerooms, and servants' quarters. The roof was supported by wooden columns set in stone.

(A) *main entrance*
(B) *private chapel*
(C) *formal garden*
(D) *well*
(E) *kitchen and steward's quarters*
(F) *servants' quarters*
(G) *stables and harness rooms*
(H) *granary*
(I) *trade entrance*
(J) *closet and bathroom*
(K) *central hall*
(L) *women's quarters*
(M) *byres*
(N) *master's quarters*
(O) *guest rooms*

had always had a dual nature, human and divine, and the latter was now emphasized. Royal dogma taught that each king was possessed by the divine ka, or soul of kingship; he was Horus, son of Osiris, mythically the last god to rule Earth in primeval times, and was identified with Amun-Ra (Amon-Re). This god, combining the Theban deity with the sun god, was tutelary deity of the empire.

The religious reformer Akhenaten (Amenhotep IV, 1379–1362 BC) carried royal absolutism to an extreme. During his reign, all endowments were transferred to a single god, a cosmic pharaoh who manifested himself as the Aten or sun-disk. At Tell el-Amarna in Middle Egypt, Akhenaten built Aten's cult center and a new royal capital. There he, his queen Nefertiti, and their children were a holy family, with the king appearing as virtually the Aten on Earth.

Possibly mentally unstable, Akhenaten was nevertheless a strong and skillful ruler. With a government staffed by loyalists, Akhenaten was aggressive abroad. His armies campaigned in the Sudan and supported Egypt's allies and vassals against the Hittites, who now dominated Syria and attacked Egyptian-held territory. Akhenaten maintained contact with the great powers and closely followed rivalries and rebellions among his vassals.

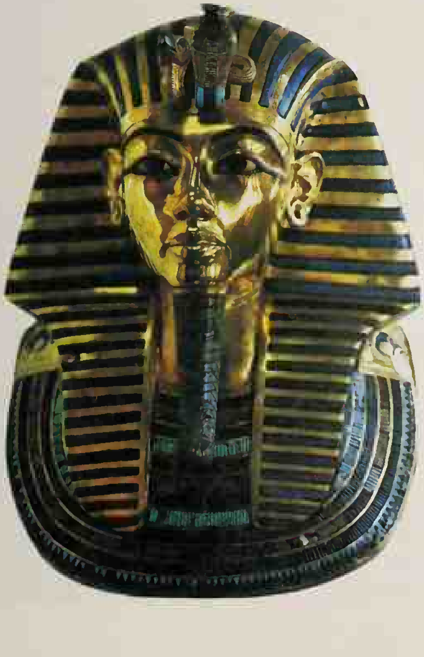
Akhenaten's innovations were ended by his successors, who restored polytheism and returned to Thebes; one, Tutankhamen, had the richest royal tomb ever to survive. Later, a new royal line, the 19th dynasty (1320–1200 BC), destroyed Akhenaten's monuments, but this dynasty maintained the same efficiently centralized government and regained territory lost in Palestine. Seti I and Ramses II fought several campaigns against the Hittites, but ultimately a peace treaty was signed. Palestine and Nubia were secure, but new threats appeared. Ramses's son Merenptah had to fight off a major invasion by hitherto minor enemies, the seminomads of Libya, who were aided by the Sea Peoples, warriors from western Anatolia and the Aegean. Internally, the 19th dynasty continued to stress the king's divinity and skillfully divided preeminence and economic benefits between Amun-Ra and the gods Ptah of Memphis and Ra of Heliopolis. It was thus less likely that any priesthood would be unduly powerful.

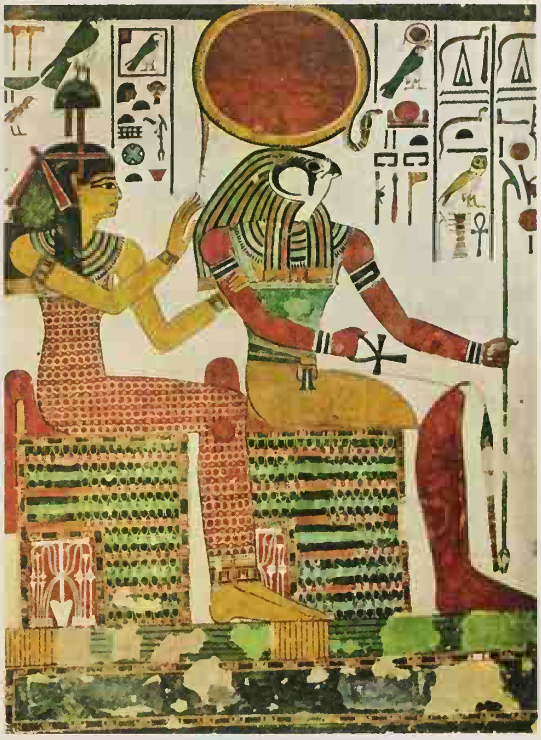
New Kingdom social history is richly documented. The New Kingdom deteriorated under the 20th dynasty, in spite of the success of RAMSES III (*c.*1198–1166 BC) in repelling invasions, and ended in civil war under Ramses XI. Social strata were clearly defined. The highest priests, soldiers, and officials received lavish rewards but were liable to disgrace or removal. Middle-class people, who included many craftsmen, were well off, as can be seen from the prosperous village of Deir el Medinah, which for 400 years housed the artisans who cut and decorated the royal tombs. Law was well developed and was probably codified, with many magistrates to administer it. Women's legal status was high; they owned and bequeathed property, initiated divorce, and sometimes served as deputies for husbands who were officials. Land remained the basis of wealth. Foreign and internal trade was dominated by the pharaoh and state institutions, but private sales were common.

New Kingdom art and architecture were varied and revealing. Stone-built gods' temples could be colossal in scale. Amun-Ra's temple at KARNAK came to occupy over 3.2 ha (8 acres). Every temple was designed to integrate Egypt ritually with the cosmos. Exterior scenes of royal victories magically protected the god's image within. Royal palaces, built in brick, deliberately copied temple architecture so as to stress the pharaoh's divinity; floor frescoes depicted resurgent nature, wall paintings showed royal victories and ceremonies, and ceilings were celestial vaults.

The minor arts were well developed. Tutankhamen's thrones and chairs were well crafted in exotic woods and exquisite jewelry, and containers in stone, metal, and other materials were frequent. Funerary items, such as coffins and BOOKS OF THE DEAD (collections of magical texts and pictures on papyrus), could also be works of art.

Tutankhamen, Akhenaten's son-in-law, was a minor king who achieved fame because his tomb survived intact. One of its treasures is the pharaoh's gold funerary mask. (Egyptian Museum, Cairo.)





A wall painting from a 19th-dynasty tomb shows two Egyptian deities: the sun god Ra (Re) with the head of a falcon surmounted by a solar disk, and Ament, goddess of the west.

Royal tombs show a radical change: the pyramid was abandoned. Nearly all New Kingdom royal tombs are tunnels cut in the walls of the remote VALLEY OF THE KINGS, their walls covered with a brightly painted underworld of gods and demons. Royal funerary cult rites were performed in temples separate from the tombs and at the foot of the cliffs fronting the valley.

Amarna art and architecture are unusual in several respects. Akhenaten modified the traditional temple type, stripping it of roofs and lintels so that its interior was completely filled with sunlight and removing the sanctuary as unnecessary. The Amarna style in sculpture and painting, while fluid and more realistic in depicting humans and animals, still adheres to many old traditions, such as making important people larger in scale and ignoring perspective.

Late Dynastic, Hellenistic, and Roman Periods. After 1085 BC, Egypt was split between a northern 21st dynasty and a line of Theban generals and high priests of Amun who controlled the south. The 22d dynasty rose from long-settled Libyan mercenaries and used a decentralized system, with kings based in the north and their sons ruling key centers elsewhere. Rivalries and sporadic civil wars resulted, and by the 8th century BC Egypt had divided into 11 autonomous states, their subjects dependent on congested, walled towns for security and exhibiting increased anxiety by adherence to local rather than national gods. Thus weakened, the country fell to Cushites, whose 25th dynasty brought limited unity and resisted Assyrian expansion into Syria-Palestine. Assyria, provoked, occupied Egypt (671, 667–664 BC), but a 26th dynasty regained independence, only to fall before Persia. The Persians ruled Egypt from 525 to 404 BC, and again from 341 to 333 BC.

Despite these vicissitudes, the country was often prosperous in the Late Dynastic period. Great temples were built, and artisans produced a steady stream of statues, often in bronze. Several much earlier styles were revived, but a quasi-realistic style, especially in statuary, also made an appearance. Later, softer, rounded contours became popular.

In the 4th century BC Egypt was wrested from Persia by Alexander the Great; Alexander's general Ptolemy (PTOLEMY I) established a Macedonian dynasty that ruled the country for over 300 years. Strong centralization and expansion abroad brought prosperity at first, but later internal dynastic conflicts encouraged rebellions. Although the Ptolemies supported traditional religion, native Egyptians resented the Greek officials' and soldiers' place over them. A Roman takeover followed the death of CLEOPATRA VII, the last Ptolemaic ruler, in 30 BC. For about two centuries conditions were favorable under the Romans; Egypt was protected from invasion, private land ownership grew, and distinctions between Hellenized and traditional Egyptians broke down.

This relief sculpture depicts a king of the 30th dynasty (380–341 BC) with the goddess Isis, who wears a vulture headdress with the moon between cow's horns.

A coin of Ptolemy I shows the founder of the 31st (Macedonian) dynasty, a general of Alexander the Great. He and his successors introduced Greek culture into Egypt.

The details of Hellenistic and Roman social, legal, and economic life are better known for Egypt than anywhere else because many papyri survived in the dry climate. Traditional life continued everywhere, Greek civilization being confined to Alexandria and a few other towns. Temples were built in traditional form, but art had a hybrid quality. Wall scenes in tombs show a mix of Egyptian and Hellenistic Greek styles and subjects. Later, emperors' faces in realistic Roman style were grafted incongruously onto traditional statues of the pharaoh, and realistic portraits, painted on wood, were integrated with Egyptian-style mummies and coffins.

Eventually, Roman policies created great problems for Egypt. Government had been by officials salaried by the state via general revenues, but a new "liturgical" system required the middle class to pay administrative costs directly. Peasants, forced to cultivate poorer lands to increase yield and onerously taxed, began to flee the countryside. In the late 3d century AD, Diocletian's reforms met the resulting economic crisis, but administrative disintegration had begun. Egypt, like the rest of the empire, became Christian, but was rebellious and heretical, and eventually was divided up among four ruling families. Distressed and divided, it fell easily before the Arab conquest of 639–42.

Egyptian language see AFROASIATIC LANGUAGES

Egyptian mythology see MYTHOLOGY

Egyptology [ee-jip-tahl'-uh-jee] Egyptology is the study of ancient Egyptian civilization. It is generally extended to include the language and archaeology of the Copts, the Christian descendants of the ancient Egyptians. The initial impetus for developing the discipline was provided by Napoleon I's ill-fated invasion of Egypt in 1798, which opened the country to European collectors and scholars and led to the formation of important collections of Egyptian antiquities in the British Museum, the Louvre, and the museums of Turin and Berlin. Napoleon was accompanied by a large body of savants whose function was to record Egypt's historical, cultural, and natural heritage. The results of their work were published in 20 massive folio volumes entitled *Description de l'Egypte* (Description of Egypt). A more important result of the invasion was the chance discovery of the ROSETTA STONE, whose bilingual inscriptions in Greek and the ancient language of Egypt enabled Jean François CHAMPOLLION to make (1822) the decisive breakthrough in the decipherment of the HIEROGLYPHIC script.

The two chief branches of Egyptology are the study of inscriptions and written documents and the study of archaeological evidence. During its life of more than 3,000 years, the language underwent substantial changes in grammar, syntax, and vocabulary, as well as in the number and character of the hieroglyphic signs used in writing it. Moreover, from a very early date (before 2650 BC), scribes, when writing in ink, often adopted a cursive hand, known as hieratic, which developed until it bore little resemblance to the hieroglyphic script. An even more cursive script, called demotic, evolved from hieratic in about the 7th century BC and continued as late as the 5th century AD. Documents in these three scripts cover a wide variety of subjects, including religion, magic, practical wisdom, *belles lettres*, history, business, personal and legal matters, medicine, mathematics, and astronomy.

Archaeological investigation is no less varied in scope. Among its many branches are scientific excavation, the classification and analysis of objects, technology, architecture, art history, and natural history. The number of monuments and the quantity of objects available for study are enormous, chiefly because of the long history and prehistory of the ancient Egyptians, the use from an early date of stone, the preservative effects of Egypt's dry climate, the rapid accumulation of wind-blown sand over edifices, and the burial of so much material of all kinds with the dead. Many sites, particularly in the Nile Delta, have not yet been systematically explored.

Ehrlich, Paul [ayr'-lik] The work on IMMUNITY of the German bacteriologist Paul Ehrlich, b. Mar. 14, 1854, d. Aug. 20, 1915, led to his coreception of the 1908 Nobel Prize for physiology or medicine. Ehrlich determined the dosages for Emil Adolf von BEHRING's diphtheria antitoxin. He then theorized that certain substances could act as "magic bullets," attacking only disease-causing organisms in the body and leaving the rest of the body unaffected. His subsequent discovery of the effectiveness of trypan dye in treating African sleeping sickness and his synthesis (1910) of Salvarsan, which was used against the syphilis organism, marked the real beginnings of chemotherapy.

Paul Ehrlich added a new dimension to the study of immunology with his search for a "magic bullet," a chemical agent for the treatment of disease. Chief among his discoveries was Salvarsan, the first cure for syphilis.

Eichendorff, Joseph, Freiherr von [y'-kuhn-dohrf] Joseph Karl Benedikt von Eichendorff, b. Mar. 10, 1788, d. Nov. 26, 1857, was the foremost German romantic nature poet and the author of *Memoirs of a Good-for-Nothing* (1826; Eng. trans., 1955), the tale of a romantically despairing youth whose dream of love is fulfilled despite his belief that the beloved is unattainable. Whereas a number of German romantics converted to Roman Catholicism, Eichendorff was born into that faith and served in the Prussian ministry of culture's division for Catholic church and school affairs.

Eichmann, Adolf [yk'-mahn] Adolf Eichmann, b. Mar. 19, 1906, d. May 31, 1962, was a German Nazi official who, as head of a special agency, supervised the hunting down and extermination of Jews during World War II. After the war he escaped to Argentina, but in 1960 he was abducted to Israel, where he was tried and hanged for his crimes.

Eiffel Tower [y'-ful] The Eiffel Tower, an immense tower of exposed latticework supports made of iron, was erected for the Paris Exposition of 1889. It was named

The Eiffel Tower, built for the Paris Exposition, the centenary of the French Revolution, rises 300 m (984 ft) above the city. When completed in 1889, it was the world's tallest structure.

after its builder, Alexandre Gustave Eiffel, who was assisted in the design by the engineers Maurice Koechlin and Émile Nouguier and the architect Stéphen Sauvestre. Built to celebrate the science and engineering achievements of its age, the 300-m (984-ft) structure consists of two visibly distinct parts, a base composed of a platform resting on four separate supports (called pylons or bents) and, above this, a slender tower created as the bents taper upward, rising above a second platform to merge in a unified column. It was the tallest structure in the world until the Empire State Building was built about 40 years later.

Eiffel was the leading European authority on the aerodynamics of high frames. The curve of the base pylons was precisely calculated so that the bending and shearing forces of the wind were progressively transformed into forces of compression, which the bents could withstand more effectively.

Eight, The see Ashcan school

18th Amendment see Constitution of the United States; Prohibition

8th Amendment see Bill of Rights; Constitution of the United States

Einaudi, Luigi [y-now'-dee] Luigi Einaudi, b. Mar. 24, 1874, d. Oct. 30, 1961, an Italian statesman and economist, was president of Italy from 1948 to 1955. A Liberal, he fled to Switzerland in 1943 to escape the Fascist regime. Returning to Italy after its liberation by the Allies, he served as head of the Bank of Italy (1945–48) and minister of the budget and vice-premier (1947). Einaudi was responsible for stabilizing the currency in 1947. In 1948 he became the first elected president of the Republic of Italy.

Eindhoven [yn'-toh-fen] Eindhoven is a Dutch city in North Brabant province, about 85 km (55 mi) southeast of Rotterdam. The population of the city is 191,002 (1988 est.). Eindhoven is the headquarters of Philips' Gloeilampenfabrieken, manufacturers of electrical and electronic equipment. Tourist attractions include the Evoluon, housing a science and technology exhibit, and the Van Abbe Museum of Modern Art (1936). The city's technical university was founded in 1957. Chartered in 1232, Eindhoven was still a small village when Philips established its plant there in 1891; growth thereafter was rapid. The city was severely damaged during World War II and has since been rebuilt.

Einstein, Albert [yn'–styn] The German-American physicist Albert Einstein, b. Ulm, Germany, Mar. 14, 1879, d. Princeton, N.J., Apr. 18, 1955, contributed more than any other scientist to the 20th-century vision of physical reality. In the wake of World War I, Einstein's theories—especially his theory of relativity—seemed to many people to point to a pure quality of human thought, one far removed from the war and its aftermath. Seldom has a scientist received such public attention for having cultivated the fruit of pure learning.

Early Life

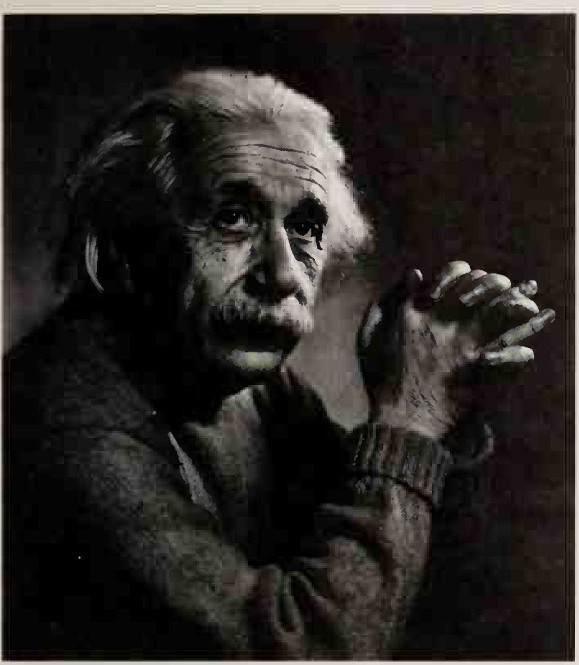
Einstein graduated in 1900 from the Zurich Polytechnic as a secondary school teacher of mathematics and physics. After a lean two years he obtained a post at the Swiss patent office in Bern. The patent-office work required Einstein's careful attention, but while employed (1902–09) there, he completed an astonishing range of publications in theoretical physics. For the most part these texts were written in his spare time and without the benefit of close contact with either the scientific literature or theoretician colleagues. Einstein submitted one of his scientific papers to the University of Zurich to obtain a Ph.D. degree in 1905. In 1908 he sent a second paper to the University of Bern and became privatdocent, or lecturer, there. The next year Einstein received a regular appointment as associate professor of physics at the University of Zurich.

By 1909, Einstein was recognized throughout German-speaking Europe as a leading scientific thinker. In quick succession he held professorships at the German University of Prague and at the Zurich Polytechnic. In 1914 he advanced to the most prestigious and best-paying post that a theoretical physicist could hold in central Europe: professor at the Kaiser-Wilhelm Gesellschaft in Berlin. Although Einstein held a cross-appointment at the University of Berlin, from this time on he never again taught regular university courses. Einstein remained on the staff at Berlin until 1933, from which time until his death (1955) he held an analogous research position at the Institute for Advanced Study in Princeton, N.J.

Scientific Work

The 1905 Papers. In the first of three seminal papers that were published in 1905, Einstein examined the phenomenon discovered by Max Planck, according to which electromagnetic energy seemed to be emitted from radiating objects in quantities that were ultimately discrete. The energy of these emitted quantities—the so-called light-quanta—was directly proportional to the frequency of the radiation. Einstein used Planck's quantum hypothesis to describe visible electromagnetic radiation, or light. According to Einstein's heuristic viewpoint, light could be imagined to consist of discrete bundles of radiation. Einstein used this interpretation to explain the photoelectric effect, by which certain metals emit electrons when illuminated by light with a given frequency. Einstein's theory, and his subsequent elaboration of it, formed the basis for much of quantum mechanics.

The second of Einstein's 1905 papers proposed what is today called the special theory of relativity. Making use of ideas from Hendrik Lorentz and James Clerk Maxwell, Einstein based his new concept of motion on a reinterpretation of the classical principle of relativity—that the laws of physics had to have the same form in any frame of reference. As a second fundamental hypothesis, Einstein



Albert Einstein revolutionized the assumptions of modern physics when he published his theory of relativity in 1905.

assumed that the speed of light remained constant in all frames of reference, as required by classical Maxwellian theory. Einstein also abandoned the hypothesis of an all-pervasive ETHER through which electromagnetic radiation was supposed to propagate. As a consequence of his theory, Einstein discovered the phenomenon of time dilation, wherein time, analogous to length and mass, is a function of the velocity of a frame of reference (see FITZGERALD-LORENTZ CONTRACTION). Later in 1905, Einstein elaborated how mass and energy were equivalent. Einstein was not the first to propose all the elements that went into the special theory of relativity; his contribution lies in having unified important parts of classical mechanics and Maxwellian electrodynamics.

The third of Einstein's seminal papers of 1905 concerned statistical mechanics, a field of study that had been elaborated by, among others, Ludwig Boltzmann and Josiah Willard Gibbs. Unaware of Gibbs' contributions, Einstein extended Boltzmann's work and calculated the average trajectory of a microscopic particle buffeted by random collisions with molecules in a fluid or in a gas. Einstein observed that his calculations could account for BROWNIAN MOTION, the apparently erratic movement of pollen in fluids. Einstein's paper provided convincing evidence for the physical existence of atom-sized molecules, which had already received much theoretical discussion.

The General Theory of Relativity. After 1905, Einstein continued working in all three of the above areas. He made important contributions to the quantum theory, but increasingly he sought to extend the special theory of relativity to phenomena involving acceleration. The key to an elaboration emerged in 1907 with the principle of equivalence, in which gravitational acceleration was held a priori indistinguishable from acceleration caused by mechanical forces; gravitational mass was therefore identical with inertial mass. Einstein elevated this identity, which is implicit in the work of Isaac Newton, to a guiding principle in his attempts to explain both electromagnetic and gravitational acceleration according to one set of physical laws. In 1907 he proposed that if mass were equivalent to energy, then the principle of equivalence required that gravitational mass would interact with the apparent mass of electromagnetic radiation, which includes light. By 1911, Einstein was able to make preliminary predictions about how a ray of light from a distant star, passing near the Sun, would appear to be attracted, or bent slightly, in the direction of the Sun's mass. At the same time, light radiated from the Sun would interact with the Sun's mass, resulting in a slight change toward the infrared end of the Sun's optical spectrum. At this juncture Einstein also knew that any new theory of GRAVITATION would have to account for a small but persistent anomaly in the perihelion motion of the planet Mercury.

About 1912, Einstein began a new phase of his gravitational research, with the help of his mathematician friend Marcel Grossmann, by phrasing his work in terms of tensor calculus. The tensor calculus greatly facilitated calculations in four-dimensional space-time (see COSMOLOGY), a notion that Einstein had obtained from Hermann Minkowski's 1907 mathematical elaboration of Einstein's own special theory of relativity. Einstein called his new work the general theory of relativity. After a number of false starts, he published (late 1915) the definitive form of the general theory. In its original form, Einstein's general relativity has been verified numerous times in the past 60 years, especially during solar-eclipse expeditions when Einstein's light-deflection prediction could be tested.

Later Life

When British eclipse expeditions in 1919 confirmed his predictions, Einstein was lionized by the popular press. Einstein's personal ethics also fired public imagination. Einstein, who after returning to Germany in 1914 did not reapply for German citizenship, was one of only a handful of German professors who remained a pacifist and did not support Germany's war aims. Einstein's political views as a pacifist and a Zionist pitted him against conservatives in Germany, who branded him a traitor and a defeatist. Just how controversial the theories of relativity remained for less flexibly minded physicists is revealed in the circumstances surrounding Einstein's reception of a Nobel prize in 1921—awarded not for relativity but for his 1905 work on the photoelectric effect.

With the rise of fascism in Germany, Einstein moved (1933) to the United States and abandoned his pacifism. He reluctantly agreed that the new menace had to be put down through force of arms. In this context Einstein sent (1939) a letter to President Franklin D. Roosevelt that urged that the United States proceed to develop an ATOMIC BOMB before Germany did. The letter, composed by Einstein's friend Leo Szilard, was one of many exchanged between the White House and Einstein, and it contributed to Roosevelt's decision to fund what became the Manhattan Project.

Until the end of his life Einstein sought a UNIFIED FIELD THEORY, whereby the phenomena of gravitation and electromagnetism could be derived from one set of equations. Few physicists followed Einstein's path in the years after 1920. Quantum mechanics, instead of general relativity, drew their attention. For his part, Einstein could never accept the new quantum mechanics with its principle of indeterminacy, as formulated by Werner Heisenberg and elaborated into a new epistemology by Niels Bohr. Although Einstein's later thoughts were neglected for decades, physicists today refer seriously and awesomely to Einstein's dream—a grand unification of physical theory.

einsteinium [yn-styn'-ee-uhm] The chemical element einsteinium is a radioactive metal of the ACTINIDE SERIES and a TRANSURANIUM ELEMENT. Its symbol is Es, its atomic number is 99, and the atomic weight of its most stable isotope is 254. Einsteinium, named for Albert Einstein, does not occur in nature. It was first discovered in the debris from the "Mike" thermonuclear explosion in the South Pacific in 1952. All known isotopes of einsteinium are radioactive.

Eire see IRELAND, HISTORY OF

Eiseley, Loren [yz'-lee] Loren Corey Eiseley, b. Lincoln, Nebr., Sept. 3, 1907, d. July 9, 1977, was an American anthropologist and author of eloquent works on science and human nature. A faculty member of the University of Pennsylvania from 1947, he was named Curator of Early Man at the University Museum in 1948. *Darwin's Century* (1958), one of Eiseley's best-known books, explores the intellectual foundations of the modern theory of evolution. His other works include *Firmament of Time* (1960), *The Unexpected Universe* (1969), *The Night Country* (1971), and his autobiography, *All the Strange Hours* (1975).

Eisenhower, Dwight D. Dwight David Eisenhower served as supreme commander of Western Allied forces during World War II, chief of staff of the U.S. Army (1945–48), president of Columbia University (1948–50), military commander of the North Atlantic Treaty Organization (NATO; 1951–52), and 34th president of the United States (1953–61).

Early Life and Career. Eisenhower was born in Denison, Tex., on Oct. 14, 1890. He grew up in Abilene, Kans., and attended the U.S. Military Academy at West Point, graduating in 1915. At the academy he was a highly regarded cadet who displayed strong qualities of leadership. On July 1, 1916, he married Mamie Geneva Doud, the daughter of a wealthy Denver, Colo., family.

Turned down for an overseas combat assignment during World War I, Eisenhower established himself as a first-rate organizer and trainer of men. From 1922 to 1924 he was executive officer to Gen. Fox Conner, military commander of the Panama Canal Zone. With Conner's help, he was admitted to the Command and General Staff School, graduating first in his class. He subsequently served on the Battle Monuments Commission under Gen. John J. Pershing, studied at the Army War College, and had a tour of duty in the office of the assistant secretary of war (1929–33).

Widely recognized as an excellent staff officer and first-class writer, Eisenhower was made administrative assistant to Army Chief of Staff Douglas MacArthur in 1933. Although MacArthur was Pershing's chief rival, Eisenhower served him loyally without alienating Pershing's followers. In 1935, when MacArthur went to the Philippines to take command of the Philippine Army, Eisenhower accompanied him.

World War II. With the outbreak of the European war in September 1939, Eisenhower returned to duty in the United States and moved rapidly through several staff and command positions. After the Japanese attack on Pearl Harbor (Dec. 7, 1941) he was called to Washington, D.C., to serve under Army Chief of Staff George C. Marshall, whose trust and confidence Eisenhower quickly won. In June 1942 he was sent to England as U.S. commander in Europe.

Eisenhower did little to determine the grand Allied strategy of World War II. He was primarily a planner, conciliator, compromiser, and public-relations figure, but these managerial qualities were essential for the leadership of a vast mid-20th-century wartime coalition. A man of democratic simplicity and outgoing warmth, he was regarded also as a tough, decisive military leader.

Eisenhower commanded the invasion of North Africa in November 1942. The North African campaign concluded victoriously in May 1943. It was followed by the conquest of Sicily in July and August 1943 and by the invasion of Italy proper in September—a difficult project that Eisenhower had not favored. Late in 1943 he was named to command the invasion of France, and he devoted all his subsequent efforts to that objective. On June 6, 1944, Allied forces invaded Normandy in a landing unparalleled in the history of warfare. Within ten weeks the Germans were driven from most of France. Eisenhower then ordered a slow, broad advance that enabled the Germans to consolidate their defenses and stage a major counterattack in the Forest of Ardennes at the end of 1944 (see BULGE, BATTLE OF THE). After this German drive was turned back, Eisenhower resumed the offensive. On May 8, 1945, Germany's unconditional surrender became effective.

After World War II, Eisenhower served a term as army chief of staff and served as president of Columbia University. In 1948 he rejected pleas that he run for the Democratic presidential nomination. In December 1950, a time when U.S. troops were retreating in the KOREAN WAR and Western Europe feared Soviet invasion, President Harry S. TRUMAN named Eisenhower military commander of NATO. Headquartered in Paris, Eisenhower enhanced

AT A GLANCE

DWIGHT DAVID EISENHOWER

34th President of the United States (1953–61)

Nickname: "Ike"

Born: Oct. 14, 1890, Denison, Tex.

Education: U.S. Military Academy, West Point, N.Y. (graduated 1915)

Profession: Soldier

Religious Affiliation: Presbyterian

Marriage: July 1, 1916, to Mary ("Mamie") Geneva Doud (1896–1979)

Children: Doud Dwight Eisenhower (1917–21); John Sheldon Doud Eisenhower (1923–)

Political Affiliation: Republican

Writings: *Crusade in Europe* (1948); *Mandate for Change* (1963); *White House Years* (2 vols., 1963–65); *Waging Peace* (1965)

Died: Mar. 28, 1969, Washington, D.C.

Buried: Abilene, Kans.

Vice-President: Richard M. Nixon

Dwight D Eisenhower

his reputation as a figure of magnetic appeal throughout the Western world.

Presidency: Election and Domestic Affairs. Urged by figures in both parties to run for president in 1952, Eisenhower was more receptive to the Republicans, who appealed to his basic conservatism. He allowed the internationalist wing of the party to adopt him as an alternative to the more isolationist candidate, Sen. Robert A. Taft. Returning to the United States to campaign in the spring of 1952, Eisenhower narrowly won the Republican nomination. In the November election, with Sen. Richard M. Nixon of California as his running mate, he defeated the Democratic candidate, Illinois governor Adlai E. Stevenson (see Stevenson family), in a landslide; facing Stevenson again in 1956, he would win by an even larger margin. However, the Republicans won Congress by only a few votes in 1952 and were ousted from control in 1954. For three-quarters of his administration, Eisenhower faced a Democratic Congress. Thus his political situation as well as his personal preferences ensured that he would not depart drastically from the policies of his Democratic predecessors.

Eisenhower liked to describe himself as a middle-of-the-roader, and his administration was a relatively faithful expression of the moderately conservative outlook of the U.S. business community. He hoped to balance the budget, hold down inflation, and give the nation efficient, economical government. He opposed any major expansion in the functions of the federal government, but he made no significant effort to repeal established programs in such policy areas as labor, agriculture, and social welfare.

Personally indifferent to the black civil rights movement, Eisenhower used federal troops to enforce school desegregation at Little Rock, Ark., in 1957; moreover, he signed civil rights acts in 1957 and 1960. He also obtained passage of two massive, but self-financing, federal public works projects—the St. Lawrence Seaway (1954) and the Interstate Highway System (1956). Solicitous of state rights, in 1953 he signed legislation vesting ownership of tidelands oil and gas deposits in the individual coastal states.

Presidency: Foreign Affairs. Eisenhower's foreign policy was built around two powerful appeals: a tough stance in the cold war against communism and the maintenance of peace. John Foster Dulles, secretary of state from 1953 to 1959, was an aggressive anti-Communist and an advocate of the liberation of Soviet-dominated nations. Eisenhower's own instincts were more conciliatory. He hoped to cut military expenditures, and in his 1952 presidential campaign he had promised to end the Korean War.

On the side of peace, caution, and conciliation, Eisenhower followed a number of paths. Having visited the Korean front before his first inauguration, he concluded a truce in July 1953 and thus ended that war without victory. In 1954 he refused to commit U.S. forces to the losing French effort in Indochina (see Vietnam War). He and other Western leaders met with a Soviet delegation headed by Nikita Khrushchev in Geneva in 1955. This summit conference led to a temporary relaxation of tensions with the USSR, and in 1959, Khrushchev made a friendly visit to the United States. In 1956, Eisenhower refrained from sending military support to the Hungarian Revolution, which Soviet troops crushed; he also dictated a cessation of hostilities between Egypt and an Anglo-French-Israeli coalition in the Suez Crisis (see also Arab-Israeli Wars). Interspersed with such episodes, however, was a continuation of the cold war. Dulles threatened "massive retaliation" against any Soviet aggression, expressed willingness to go "to the brink" of war, and condemned neutrality. The Central Intelligence Agency (CIA) covertly established anti-Communist regimes in Iran (1953) and Guatemala (1954); it also engaged in less successful actions in Indonesia (1958) and Laos (1960) and began to plot against pro-Communist Cuban dictator Fidel Castro.

The administration concluded a mutual defense treaty (ratified 1955) with Chiang Kai-shek's Nationalist Chinese government on Taiwan and twice risked war over Communist attempts to occupy the Nationalist-held islands of Quemoy and Matsu. Following the Geneva Conference (1954) that partitioned Vietnam, Eisenhower's administration established the anti-Communist government in South Vietnam and developed it as a bastion against the Communist North. A further step in this direction was the establishment of the Southeast Asia Treaty Organization (SEATO) in 1954, the first of a series of alliance systems directed against Communist expansion in the underdeveloped world. The United States supported the Baghdad Pact of 1955, which had the same objective for the Middle East (see Central Treaty Organization). In 1957, at Eisenhower's request, Congress authorized possible U.S. military action in that area (the "Eisenhower Doctrine"). In 1958, after the pro-Western monarchy of Iraq was overthrown, U.S. troops landed in Lebanon; they were withdrawn, however, after a 3-month, bloodless presence.

During Eisenhower's last two years in office, relations with the USSR deteriorated. The Soviet government threatened to compel U.S. withdrawal from Berlin, and Eisenhower's administration refused to make concessions. In May 1960, on the eve of a critical summit conference in Paris, the Soviets shot down an American U-2 spy plane and captured its pilot. Eisenhower took full responsibility for the espionage, and the Paris conference became a forum for Soviet anger. As the Eisenhower presidency ended, the cold war had intensified and war over Berlin seemed possible.

By then, Eisenhower's health was precarious. He had suffered a major heart attack in 1955, had undergone surgery for ileitis in 1956, and had sustained a mild stroke in 1957. The 22d Amendment to the Constitution prevented his candidacy for a third term, but he remained nearly as popular as when first elected. He supported Vice-President Nixon for the Republican nomination in 1960 and saw him defeated by the Democratic candidate, Massachusetts senator John F. Kennedy.

Eisenhower retired to his farm in Gettysburg, Pa., in 1961 and died in Washington, D.C., on Mar. 28, 1969.

Eisenman, Peter Peter David Eisenman, b. Newark, N.J., Aug. 11, 1932, is a controversial American architect who founded (1967) and directed the Institute for Architecture and Urban Studies in New York City. At the institute he created an active and polemical architectural forum. Along with Michael Graves, Charles Gwathmey, Richard Meier, and John Hejduk, Eisenman was one of the architects known as the New York Five. In his few residential buildings, which are based on an abstraction and manipulation of structure, he attempts to draw attention to architecture almost as shock therapy. His first major building was the Wexner Center for the Visual Arts at Ohio State University, (1989; with Richard Trott).

Eisenstaedt, Alfred [yz'-en-staht] Alfred Eisenstaedt, b. West Prussia, Dec. 6, 1898, has been called the father of photojournalism. Starting in Berlin in 1929 with Pacific and Atlantic Photos (taken over by the Associated Press in 1931), he produced candid but incisive documentary photographs and portraits and in 1936 became one of the original staff photographers of *Life* magazine. Combining a significant subject with strong formal composition, he won acclaim for such works as *Feet of an Ethiopian Soldier* (1935), *Nurses Attending a Lecture* (1937), and his 1945–46 photographs from Japan. Since World War II, Eisenstaedt has photographed hundreds of prominent people and published several collections of his work.

Alfred Eisenstaedt's exuberant photo V-J Day *captures the euphoria of Americans over the end of World War II. Born and educated in Germany, Eisenstaedt began his professional career there in 1929.*

Eisenstein, Sergei Mikhailovich [yz'-en-shtine, sir-gay' mee-ky'-loh-vich] Soviet filmmaker Sergei

The brutality of tsarist repression is recaptured in the climactic scene from Sergei Eisenstein's epic film The Battleship Potemkin *(1925). Eisenstein is regarded as one of the pioneering figures in the development of motion pictures.*

Eisenstein, b. Jan. 23 (N.S.), 1898, d. Feb. 11, 1948, was a seminal figure in the history of film. His stylistic innovations and theory of montage are still studied.

As a designer and director for the Proletcult Theatre in Moscow, Eisenstein and his experimental group staged Aleksandr Ostrovsky's *Even a Wise Man Stumbles* (1923) as a circus including a short film interlude. Placed in charge of Proletcult's first large film project, *Towards the Dictatorship of the Proletariat,* envisioned as a series of seven historical films, Eisenstein began work on *Strike* (1925). Combining exaggerated theatrical elements with some of the most realistic footage ever filmed by Eisenstein, this was recognized for its artistic and political power. Eisenstein's next film, *The Battleship Potemkin* (1925), a treatment of the June 1905 naval mutiny, demonstrated abroad that the USSR could produce an original film masterpiece and also demonstrated Eisenstein's use of montage, a revolutionary film-editing technique. *October* (1928), also known as *Ten Days That Shook the World,* was similarly innovative. A propaganda film (*The General Line*) on behalf of the collectivization of Soviet agriculture was released in 1929 under the title *Old and New*. Between 1929 and 1932 Eisenstein studied foreign sound-film systems in western Europe; signed a contract with Paramount Pictures (later canceled); and, with the financial backing of Upton Sinclair, began filming an epic of Mexican culture to be called *Que Viva Mexico!* (of which the Sinclairs seized all footage after production was halted in 1932).

In the USSR in the 1930s, Stalin's socialist realism supplanted earlier Soviet experimentalism. The historical drama *Alexander Nevsky* (1938) temporarily restored Eisenstein to favor, besides showing what he could do in sound film (in collaboration with composer Sergei Prokofiev). His last film, made in Kazakhstan during World War II, was *Ivan the Terrible* (1944–46).

Eisler, Hanns The work of German composer Hanns Eisler, b. July 6, 1898, d. 1962, is associated with his commitment to Marxism and his belief in the social role of music. He was also, however, the most successful 20th-century composer of German art songs and songs for children. He worked with dramatists such as Bertolt Brecht, and his marching songs became famous throughout left-wing movements in Europe and America.

Eisler worked in Hollywood from 1942 to 1947. After being questioned by the House Committee on UN-AMERICAN ACTIVITIES about his beliefs, he moved to Berlin.

Eisner, Kurt [ise'-nur] Kurt Eisner, b. May 14, 1867, d. Feb. 21, 1919, was a German Socialist best known for organizing a leftist revolution that overthrew the monarchy in Bavaria at the end of World War I. A longtime member of the Social Democratic party, Eisner edited (1899–1905) its newspaper, *Vorwärts*. When Germany was on the verge of surrender in November 1918, Eisner organized a revolution in Bavaria and appointed himself head of a new republican government. A few months later he was assassinated by a royalist.

Eitoku [ay'-toh-koo] The Japanese artist Kano Eitoku, 1543–90, grandson of MOTONOBU, was official painter to the military leaders Nobunaga and Hideyoshi. Eitoku perfected a style of mural painting based on lavish use of gold leaf and bold decorative forms that epitomizes the opulent spirit of Japan's Momoyama period (1573–1614). This style was executed on large-scale screens and sliding doors for the castles of his patrons. Surviving works include the *Chinese Lions* screen (Imperial Collection, Tokyo).

Ekman, Vagn Walfrid [ayk'-mahn] The Swedish oceanographer Vagn Walfrid Ekman, b. May 3, 1874, d. Mar. 9, 1954, made basic contributions to the study of the dynamics of OCEAN CURRENTS and is considered one of the founders of modern OCEANOGRAPHY. Ekman is best known for his theoretical study of the effect of the Earth's rotation on wind-driven currents (see CORIOLIS EFFECT). He did pioneering work in the field of ocean turbulence and was also a skilled experimentalist; his Ekman current meter, gravity corer, and reversing water bottle represented major advances in oceanographic instrumentation.

El Alamein see WORLD WAR II

El Cid [el sid'] Rodrigo Díaz de Vivar, d. July 10, 1099, was a famous warrior in 11th-century Spain, whose exploits formed the subject matter of the great Castilian epic the *Poem of the Cid*. Known to the Moors as *el Cid* (lord), he was exiled (1081) from Castile by ALFONSO VI because of the jealousy of other nobles. Although he spent many years in the service of other rulers, he always remained loyal to his king. In 1094 he seized the Muslim city of Valencia and ruled it as lord until his death, after which his widow abandoned it to the Moors. The *History of Rodrigo* is a contemporary Latin prose account of his deeds.

See also: CID, THE.

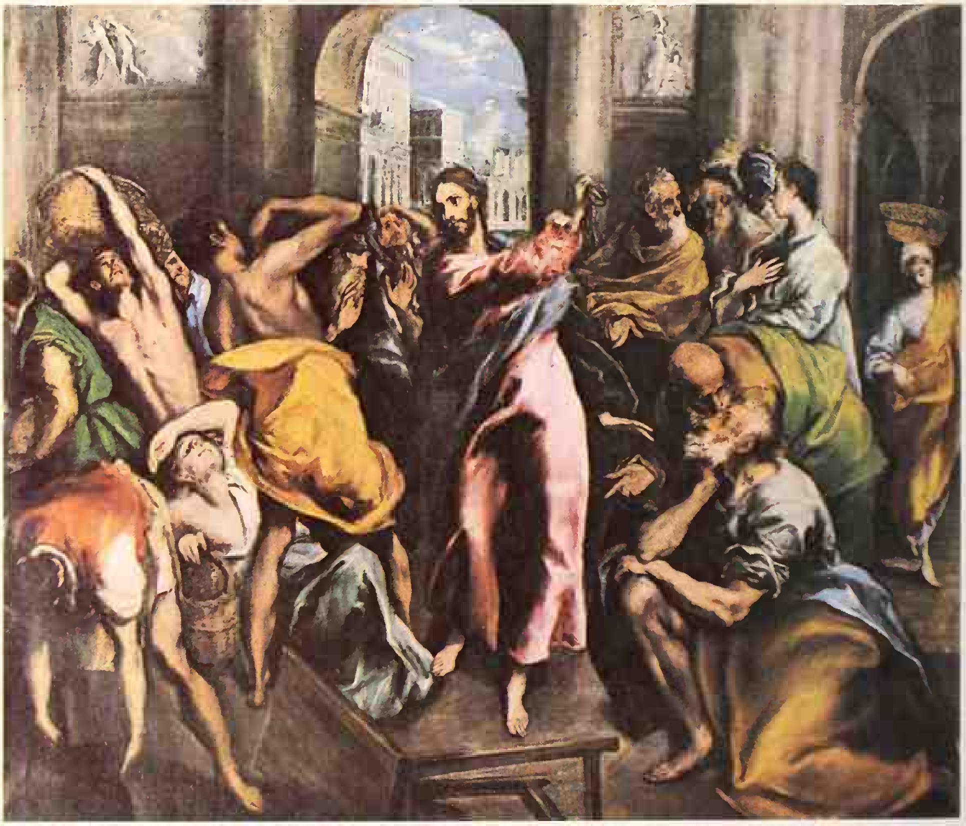
El Cordobés [el kohr-doh-bays'] Manuel Benitez Pérez, b. Palma del Rio, Spain, May 4, 1936, was considered the most exciting matador during most of his career (1963–72) of challenging the bulls. An orphan, he adopted his name from the town of Córdoba, where he fought his first bulls. In 1964 he was gored, but a year later he fought 111 times to break the record set by Juan BELMONTE. El Cordobés dared bulls by dropping to his knees in front of them and jumping on their backs; because of such feats, his huge following forgave his lack of elegance.

El Dorado El Dorado, a legendary country abounding in gold, was rumored in the 16th and 17th centuries to exist somewhere in South America. The name of the country, which in Spanish means "gilded man," was derived from its alleged ruler, who was so rich that he covered his body with gold dust each day and then washed it off in a lake each evening. The legend probably originated among the CHIBCHA Indians, who inhabited the highlands around present-day Bogotá, Colombia. The Chibcha anointed each new chief with resinous gums and covered his body with gold dust. The chief then plunged into the sacred Lake Guatavita and washed off the gold as an offering to the Earth gods.

The Spanish discovery of the rich cities of the Aztecs and the Incas helped develop the story of El Dorado into the legend of a whole country filled with treasure. Beginning about 1530, a long series of expeditions was organized by Europeans to search for El Dorado and the fabled cities of Manoa and Omagua.

El Greco El Greco, as Domenikos Theotokopuli, b. Candia, Crete, 1541, d. 1614, was known in Spain, was the most outstanding painter of the Spanish school in the 16th century. Factual details of his youth and artistic training are extremely scanty. He was probably first apprenticed as a painter of religious pictures in the Greco-Byzantine tradition. Crete was a dependency of Venice, and the young artist undoubtedly emigrated to the Italian city for further study.

In 1570 he seems to have arrived in Rome, introduced



El Greco's work The Purification of the Temple *(c. 1600) combines charged emotionalism and asceticism, a distinguishing mark of his painting. Originally influenced by the realism of the Venetian Renaissance artists, El Greco increasingly used abstract and exaggerated forms to convey the spiritual, unworldly import of his subjects. (National Gallery, London.)*

as a pupil of the Venetian master TITIAN, and he entered the Roman painters' guild in September 1572. It is reported that during the pontificate of Pius V (1566–72), El Greco, by offering to repaint Michelangelo's *Last Judgment* in the Sistine Chapel, made himself unpopular in Rome and was obliged to move to Spain. Whatever the length of his stay in Italy, he was clearly influenced by the sensuous colorism of Titian, the realism of Jacopo Bassano (see BASSANO family), the spiritualized figural style of MICHELANGELO, and particularly by the dramatic energy and compositional complexity of TINTORETTO.

El Greco arrived in Toledo from Madrid in 1577 to undertake an important series of religious paintings, *The Disrobing of Christ* (1577–79; Toledo Cathedral). In 1580–82 he painted *The Martyrdom of Saint Maurice* for King Philip II's immense palace-monastery of the Escorial. The painting failed to please the king, however, further encouraging El Greco to remain settled permanently in Toledo, where the numerous religious foundations provided a steady source of commissions. Financial difficulties seem to have forced the artist into intensive productivity, aided by studio assistants, usually resulting in several versions of each major composition.

In Toledo, El Greco moved away from a relatively naturalistic style derived from the Venetian Renaissance to one involving an antinaturalistic elongation of figures, flickering light, and intense colors, as in *The Burial of the Conde de Orgaz* (1586; Santo Tomé, Toledo), and finally to the visionary expressionism and extreme abstraction of forms seen in *The Agony in the Garden* (*c.*1597–1603; Toledo Museum, Ohio). In addition to his religious works, El Greco produced many portraits of extraordinary psychological penetration, such as *Cardinal-Inquisitor Fernando Niño de Guevara* (*c.*1600; Metropolitan Museum, New York City); mythological subjects, such as *Laocoön* (*c.*1608–14; National Gallery, Washington, D.C.); and visionary landscapes, which are represented by his views of Toledo (*c.*1595–1614; Metropolitan Museum of Art and the Greco Museum, Toledo). El Greco was also an accomplished sculptor, and he designed settings for two altarpieces (1577).

The intense emotionalism and spirituality of El Greco's art mark him as one of the last and greatest inheritors of the 16th-century international Mannerist style (see MANNERISM). His mysticism was ideally suited to the fervent religious climate of Counter-Reformation Toledo, but his style was not easily transmitted, and he had no important followers. Soon after his death Spain was to move toward a more sober and down-to-earth art influenced by the Italian baroque realist Caravaggio. The art of El Greco was neglected for three centuries, until the artists of the late 19th and early 20th centuries, with their interest in distortion and abstraction of form and in emotional expressionism, restored the painter's reputation as one of Spain's leading masters.

El Niño [el neen'-yoh] El Niño, a seasonal OCEAN CURRENT that flows southward along the coast of northern Peru, is often associated with atmospheric changes; scientists generally refer to El Niño and related phenomena as the El Niño–Southern Oscillation (ENSO). The current itself is warm, nutrient-poor, and relatively low in salinity. Its name (Spanish, "the child") is derived from its arrival during the Christmas season. Best developed from January to March, it usually moves just south of the equator before converging with the Peru Current. El Niño is an extension of the equatorial countercurrent, which turns south along the coast of Ecuador.

Every three to five years, in a self-sustaining cycle that is only partially understood, a weakening of normally strong southeasterly TRADE WINDS allows the warm waters of the El Niño to extend farther south. Water temperatures then rise several degrees above average, with catastrophic results. The higher temperature along the coast kills planktonic organisms and fish, thus harming the major fishing industry in the area; important guano-producing birds starve or abandon their nests. The higher temperature also causes increased evaporation, which in turn produces excessive rainfall on some land areas. A major ENSO disturbance affects other ocean-current patterns and causes widespread climatic changes over the Western Hemisphere and even over Europe and Asia, as well as over the southern Pacific Ocean. Disastrous flooding and DROUGHTS may result in some areas. Researchers have developed models of tropical OCEAN-ATMOSPHERE INTERACTIONS that enable them to successfully predict ENSO variations and better forecast climatic disturbances.

El Paso [el pas'-oh] El Paso, a city in extreme western Texas, is situated on the north bank of the Rio Grande at an altitude of 1,147 m (3,762 ft) opposite Ciudad Juárez, Mexico. It has a population of 515,342 (1990) and is the seat of El Paso County. El Paso is located in a region of cattle ranches and irrigated farms, which produce cotton, fruits, and vegetables. It is a commercial and manufacturing center, and its economy is based on the processing of foods, petroleum, and primary metals, as well as the manufacture of apparel and machinery. A port of entry, it is served by major Mexican and U.S. highways and railroads. The University of Texas has a branch there, and Fort Bliss (established 1849), a U.S. Army post, is nearby.

El Paso (Spanish for "the pass") received its name in 1598 from Juan de Oñate, a colonizer of New Mexico. Although 16th- and 17th-century traders, missionaries, and soldiers regularly used this mountain route to the north, the north bank of the river was not settled until 1827. In 1848 the site was declared U.S. territory. The arrival of several railroads after 1881 greatly spurred population growth. Changes in the course of the Rio Grande after 1848 caused the Chamizal border dispute, which was finally settled in 1963 with the ceding of the 177-ha (437-acre) tract to Mexico.

El Salvador [el sal'-vuh-dohr or sahl-vah-dohr'] Located on the Pacific coast of Central America between Guatemala and Honduras, the Republic of El Salvador is

AT A GLANCE

REPUBLIC OF EL SALVADOR

Land: Area: 21,040 km^2 (8,124 mi^2). Capital and largest city: San Salvador (1985 est. pop., 462,652).

People: Population (1990 est.): 5,309,865. Density: 252 persons per km^2 (654 per mi^2). Distribution (1989): 43% urban, 57% rural. Official language: Spanish. Major religion: Roman Catholicism.

Government: Type: republic. Legislature: Legislative Assembly. Political subdivisions: 14 departments.

Economy: GDP (1988): $5.5 billion; $1,020 per capita. Labor distribution (1984): agriculture—40%; manufacturing—15%; commerce—16%; government—13%; finance—9%; transportation—6%. Foreign trade (1989): imports—$1.1 billion; exports—$497 million. Currency: 1 colón = 100 centavos.

Education and Health: Literacy (1988): 65% of adult population. Universities (1987): 4. Hospital beds (1985): 4,224. Physicians (1985) 1,649. Life expectancy (1990): women—68; men—62. Infant mortality (1990): 49 per 1,000 live births.

the most densely populated of the Latin American countries. It is the smallest republic of the American mainland and the only Central American country not bordering the Caribbean Sea. El Salvador's economic well-being depends on its coffee production and fluctuates with the world market.

Land and Resources

El Salvador can be divided into three major physical regions: a tropical coastal belt on the Pacific, a central upland area of valleys and plateaus, and a mountainous north. Most of the population is concentrated in the subtropical central region, where the major cities of San Salvador (the capital), Santa Ana, San Miguel, Sonsonate, and San Vicente are located. This region is subject to earthquakes, such as those which devastated San Salvador in 1965 and 1986. There are more than 20 active volcanoes in the north, and nearly all of the country's soil is volcanic. El Salvador's highest point is Santa Ana Volcano, at 2,382 m (7,815 ft).

Rainfall is concentrated in the months from May to October, and distribution varies from 1,140 mm (45 in) in the interior and 1,725 mm (68 in) in the Pacific lowlands to 2,460 mm (97 in) in the mountains. Temperatures average 23° C (73° F) in the capital but are much higher along the coast.

El Salvador is considered one of the most environmentally damaged nations in Latin America. The country's once-dense forest cover has all but disappeared, and erosion and pollution are serious problems. Known mineral deposits are scanty.

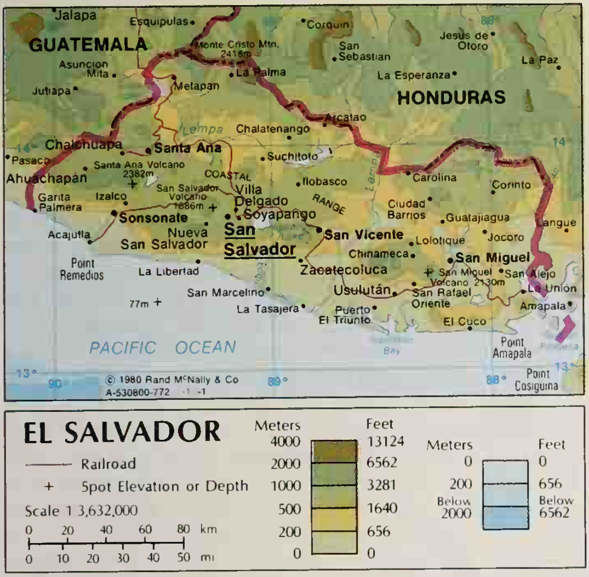
People

The majority (about 90%) of Salvadorans are mestizos, people of mixed Spanish-Indian ancestry. Most of the remainder are Indians. Nearly 95% of the people are Roman Catholic. Because of the high population density, rapid growth rate, and the widespread political violence since the 1970s, many Salvadorans have migrated to Honduras or the United States to seek better living conditions. Primary education is free and compulsory, but many children do not attend school.

Economic Activity

To a large measure, El Salvador's chronic political unrest can be traced to its extremes of wealth and poverty. The population is primarily rural and agricultural. Less than 2% of the population own more than 60% of the land (including most of the coffee plantations) and control the nation's productive capacity, while the poorest 20% own no land and receive only 2% of the national income. A land-reform program initiated in 1980 was of limited success, and unemployment and underemployment are high. Between 1980 and 1990 it is estimated that civil war caused nearly $2 billion in damage to the nation's factories, plantations, and infrastructure, while per capita income declined by about one-third.

Coffee replaced indigo as El Salvador's main export by the 1880s and remains the leading export, followed by cotton, sugar, and shrimp. Rice and maize are grown for local consumption. Nearly all arable land is under cultivation. Although El Salvador is one of the most industrial-



ized nations in Central America, industry, like agriculture, has been adversely affected by civil strife. Manufactures include processed foodstuffs, textiles, clothing, and pharmaceuticals.

History and Government

Before Spanish conquest in the 16th century, the area of El Salvador was divided among several Indian groups, of which the Pipil, whose culture resembled that of the Aztecs, were dominant. The region was under Spanish rule from 1524 until 1821. In 1823, El Salvador joined the Central American Federation, of which San Salvador was the capital from 1834. After the dissolution (1838–40) of the federation, El Salvador was involved in a series of other short-lived unions and was subject to constant interference from Guatemala and Nicaragua.

Military governments since 1931 often responded to political unrest with violent repression. Tensions resulting from the large-scale emigration of Salvadorans into Honduras led to a brief border war (July 1969).

Political violence increased sharply after the 1977 election in which Gen. Carlos Humberto Romero became president. He was deposed in October 1979, but the military-civilian junta that replaced him was unable to stop the civil war between leftists and rightists. Archbishop Oscar Arnulfo Romero, associated with the left, was assassinated in 1980.

Under pressure from the United States to institute reforms, the junta named José Napoléon Duarte, leader of the moderate Christian Democratic party, as president in December 1980. The United States, charging that the two main leftist groups—the Farabundo Martí National Liberation Front (FMLN) and the Revolutionary Democratic Front (FDR)—were being helped by Nicaragua, Cuba, and the USSR, increased its military and economic aid to the Salvadoran government. In a 1982 election boycotted by the FMLN-FDR alliance, a constituent assembly was chosen to draw up a new constitution. Dominated by the rightist National Republican Alliance (Arena), the assembly curtailed the Christian Democratic land-reform program. The new constitution was adopted in 1983, but in 1984, Duarte defeated Arena leader Roberto D'Aubuisson to win the presidency. Despite various peace efforts, including El Salvador's participation in

Plaza Libertad, in the center of San Salvador, commemorates independence from Spanish rule in 1821. San Salvador, the nation's capital and largest city, was founded (1525) by Jorge de Alvarado.

the 1987 Central American peace plan, the civil war continued. Coupled with a 1986 San Salvador earthquake and 1987 drought, the war badly damaged the economy. Duarte was succeeded as president on June 1, 1989, by Alfredo Cristiani of Arena. By 1990, as fighting and rights' abuses surged and subsided, the civil war had claimed more than 70,000 lives. Agreement to permit the United Nations to monitor human rights violations after a cease-fire was reached in July 1990, but later talks failed to produce a cease-fire accord.

El Tajín [el tah-heen'] El Tajín, a major archaeological site in northern Veracruz, Mexico, dominated the Gulf coast in the second half of the 1st millennium AD. The site is noted for its distinctive architectural style and for its marked emphasis on the sacred Mesoamerican ball game, which was played in ritually significant and very elaborately decorated masonry courts.

About AD 100, El Tajín emerged as a minor ceremonial-civic center with a few small temples and palaces. Architecture and pottery suggest that it was an outpost of TEOTIHUACÁN, the powerful central Mexican city. With the waning of Teotihuacán influence after 500, Tajín flourished, extending its own influence throughout the Gulf coast and to areas as distant as southern Guatemala. The center was destroyed by fire *c.*1100.

At its peak El Tajín occupied 5 km^2 (about 2 mi^2), with a public zone of temples, palaces, and 11 ball courts surrounded by ordinary dwellings. The dominant building is an 18-m-high (60-ft) temple-pyramid pierced by 365 niches, which probably figured in calendrical rites.

Elagabalus see HELIOGABALUS, ROMAN EMPEROR

Elam [ee'-luhm] Elam was an ancient name for the region of southwestern Iran known today as Khuzestan. Its capital was Susa, and the territory also contained the kingdom of Anshan, the ancestral home of the Persian conqueror Cyrus the Great. Because Elam had access to the Persian Gulf and lay astride an east-west trade route, it became militarily and economically important.

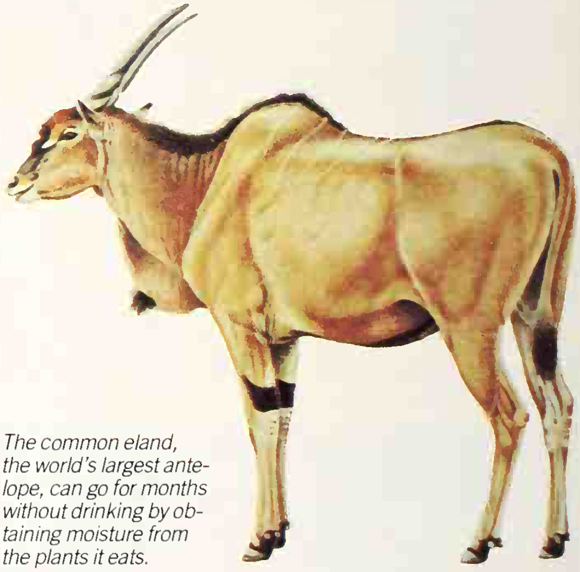
After an independent cultural existence in the 4th millennium BC, Elam came under the influence of MESOPOTAMIA, subsequently borrowing much from SUMER. During the 3d millennium BC Elam was on occasion tributary to powerful Mesopotamian kingdoms, but after 2000 BC vigorous Elamite kings raided and sometimes controlled extreme southern Mesopotamia.

These raids initiated the so-called Elamite Period, which lasted from *c.*2000 BC to 640 BC. The era of King Untashgal (*c.*1265–1245) and his successors in particular produced spectacular architecture and sculpture at the site of Choga Zanbil (Dur-Untash). This era of power and prosperity was terminated in 1130 by a damaging Babylonian raid, although Elam later reemerged (8th–7th century) as a dangerous enemy of Assyria. Finally succumbing (7th century) to Assyrian battering and the rise of MEDIA, Elam became a province in the empires of the Persians and their successors.

The Elamites spoke a unique language, not related to any other. Elam was also unusual in having a matriarchal social structure: although the rulers were male, succession to the throne was through the female line.

eland [ee'-luhnd] Elands are spiral-horned ANTELOPES that constitute the genus *Taurotragus,* belonging to the family Bovidae, order Artiodactyla. They stand 180 cm (6 ft) tall at the shoulder, are up to 340 cm (11 ft) long, and may weigh 545 kg (1,200 lb). The coat is grayish or tawny, with a short mane and a matching patch of hairs on the throat. Both sexes have horns.

Elands live in central and southern Africa, preferably in grasslands with scattered trees. The female bears a single calf. The life span is about 15 years.



The common eland, the world's largest antelope, can go for months without drinking by obtaining moisture from the plants it eats.

Elat [ay'-laht] Elat (Eilat, Elath) is a seaport in southern Israel, at the head of the Gulf of AQABA. The population of the city is 18,800 (1984 est.). Elat is Israel's major access port to the Red Sea and has an oil pipeline terminal. Its mild, dry climate makes it a popular vacation resort. Located near the ancient Ezion-Geber of the Bible, Elat is said to be the site of King Solomon's port for shipping metals mined nearby. The ARAB-ISRAELI WAR of 1967 started when Egypt blocked Elat's shipping at the mouth of the Gulf of Aqaba.

Elba Elba is the largest island of the Tuscan Archipelago and part of the province of Livorno, Italy. It lies in the Tyrrhenian Sea between Corsica and the Italian mainland, from which it is 11 km (7 mi) distant. The mountainous island has a population of 28,907 (1984 est.) and an area of 223 km^2 (86 mi^2). Its highest point is the 1,019-m (3,343-ft) Monte Capanne. The port of Portoferraio is the chief industrial center. Olives, grapes, and grains are grown; tourism and fishing are also important to the economy. Since ancient times, it has been a source of iron ore. Settled by Ligurians and later by Etruscans, Elba was occupied by Greeks in the 5th century BC and later by the Romans. It was the site of the first exile (1814–15) of NAPOLEON I who ruled it as a principality. In 1860, Elba became part of Italy.

Elbe River [el'-beh] The Elbe River (called the Labe in Czechoslovakia), an important waterway in central Europe, flows 1,165 km (724 mi) from its source in the Riesengebirge (Giant Mountains) of Czechoslovakia west and northwest across Germany to empty into the North Sea at Cuxhaven near HAMBURG. The Elbe drains a basin of 144,056 km^2 (55,620 mi^2). Its tributaries include the Vltava, Ohře, Mulde, and Saale rivers on the south and southwest and the Iser, Black Elster, Havel, and Alster rivers on the north and northeast.

Navigable for more than 805 km (500 mi), the Elbe is connected to the Ruhr, Rhine, and Weser rivers by the Mittelland Canal system, to the Baltic Sea by the Elbe-Lübeck and Kiel canals, and to the waterways surrounding Berlin by the Elbe-Havel Canal. Thus many cities on its banks, notably DRESDEN, MAGDEBURG, Hamburg, Schönebeck, and Aken, are important river ports.

Known to the Romans as the Albis, the river marked the limit of the Romans' farthest advance in Germany in 9 BC. Toward the close of World War II, Soviet and U.S. forces met near Torgau on the Elbe.

Elbert, Mount [el'-burt] Mount Elbert, in central Colorado, is the highest peak (4,399 m/14,431 ft) in the American Rockies. It is located in the Sawatch Mountains in White River National Forest.

Elbrus, Mount [ayl-broos'] Mount Elbrus, the highest peak in Europe, is located in the northwestern CAUCASUS MOUNTAINS of the Georgian republic of the USSR. An extinct volcano formed during the Tertiary Period, its two cones rise to 5,642 m (18,510 ft) and 5,633 m (18,481 ft). Its glaciers feed the Kuban, Malka, and Baksan rivers.

Elburz Mountains [el-boorz'] The Elburz Mountains, in northern Iran, extend 1,000 km (625 mi) between the central Iranian plateau and the Caspian Sea. The range's highest peak is Mount Demavend, which rises 5,771 m (18,934 ft). The system consists of a series of steep, narrow, parallel ranges. The southern slopes are dry; the northern slopes are wetter and forested. The width of the ranges varies from 24 km (15 mi) at the western end to 120 km (75 mi) near Tehran. The Safid Rud, a river, provides a natural pass across these mountains.

elderberry Elderberry, or elder, genus *Sambucus,* is any of several deciduous shrubs or small trees belonging to the honeysuckle family, Caprifoliaceae. These plants have compound leaves, showy clusters of white flowers, and red or black berries, called elderberries. The berries of *S. nigra* and *S. canadensis* are used in some localities for making wine. The fruit is also used for making jelly and pies. European elder, *S. nigra,* grows to a height of 9 m (30 ft) and produces yellow white flowers in clusters up to 20 cm (8 in) across. American, or sweet, elder, *S. canadensis,* produces purplish black berries. Other elders include American red elder, *S. pubens,* and European red elder, *S. racenosa.*

Eleanor of Aquitaine Eleanor of Aquitaine, b. 1122, d. Apr. 1, 1204, renowned for her intelligence and great beauty, was queen to two kings and mother of two others, and a patroness of courtly literature. Heiress of the duchy of Aquitaine, she married LOUIS VII of France in 1137. She accompanied (1147) him on the Second Crusade, where her conduct led Louis to doubt her fidelity. Although consanguinity was the official reason for the annulment of their marriage in 1152, basic incompatibility was the real reason.

Eleanor then married Henry of Anjou, soon to become (1154) King HENRY II of England. By this marriage her inheritance passed to the English crown. Having supported her sons in revolt (1173) against their father, she spent most of the rest of Henry's reign locked in a tower. A dominant figure in English politics during the reign (1189–1204) of her son RICHARD I, she supported the succession of her youngest son, JOHN, before returning to her native Aquitaine at the end of her life.

Eleatic School [el-ee-at'-ik] The Eleatic School was a group of pre-Socratic philosophers who were active in Elea, a Greek community in southern Italy. Their dominant characteristic was a denial of all change, motion, and plurality in the world. PARMENIDES, the group's leading figure, held that all change and plurality are unintelligible. It is impossible to think "what is not." The object of thought is, therefore, undivided and unchanging. Being underlies everything that exists; therefore, nothing stands in contrast to it. Parmenides' followers, ZENO OF ELEA and Melissus of Samos, also argued for this radical MONISM.

election An election is a method of choosing leaders or making decisions by a process of voting. Ancient Athens had a system of elections in which all citizens could vote. With the birth of modern democracy, elections have become a universal way of choosing legislative representatives and government leaders and are standard practice in many public and private organizations. Elections are not confined to democracies; they have also been used in authoritarian kinds of government. Rulers who are not accountable to the people may be elected by the vote of an elite group, such as a feudal aristocracy or party bosses.

Electoral Rules

Elections are never entirely free; they are conducted according to various rules and restrictions. First, elections are limited to those who have the right to vote (see SUFFRAGE). Early in the 19th century the franchise in those countries which had popularly elected governmental institutions was limited by such factors as sex, race, religion, age, place of residence, and property qualifications. Even in the United States, the first modern democracy, suffrage was limited to white males who could meet certain property qualifications. It was soon extended to most white adult male citizens, but women were not allowed to vote in the United States until 1920, when the 19TH AMENDMENT to the Constitution was ratified (see SUFFRAGE, WOMEN'S). Despite the 15th Amendment (1870), guaranteeing the vote to all citizens regardless of race, many African Americans were effectively denied the franchise until the CIVIL RIGHTS ACTS of the 1960s. All citizens 18 or over were given the right to vote in 1971 by the 26th Amendment. In order to exercise their voting rights, citizens must register as voters under the local electoral laws. These require proof of age and residency in the relevant electoral district. (See VOTER REGISTRATION.)

Methods of conducting elections are often complex. If only two candidates are competing, a simple majority of the votes may decide the winner. Often, however, there are three or more candidates, and then no majority may be possible. The rules in such cases may stipulate a further election or a runoff between the two candidates who received the most votes in the first election; otherwise, the candidate with the largest number of votes (a plurality) may be declared the winner. Special rules are necessary when members of legislative bodies are elected by PROPORTIONAL REPRESENTATION, which is a system designed to ensure the representation of minority political groups.

In the United States a general election is almost always preceded by a PRIMARY ELECTION, in which the candidates of each party are chosen. Primary elections arose late in the 19th century in the South, where the predominance of the Democratic party assured victory to its candidates. The practice spread to Wisconsin and other states in the early 20th century as a means of giving voters more say in the selection of candidates than they could obtain through party conventions. Some states even have open primaries, in which voters can choose a party's candidates without previously having been registered members of that particular party. In recent years there has been an increase in the use of presidential primaries, in which voters select delegates to national party conven-

(Above) *Election paraphernalia in Argentina resembles that elsewhere in the world. This array promotes Raúl Alfonsín, who won the presidency in popular elections in 1983.* (Right) *Brian Mulroney, in Canada, captured the leadership of the Progressive Conservative party at the party's convention in June 1983; in September 1984 his party won the general elections, making Mulroney prime minister.*

tions on the basis of their commitment to one or another presidential candidate.

Elections may be direct or indirect. In an indirect election the voter chooses someone to vote for him, as in U.S. presidential elections under the ELECTORAL COLLEGE system. France, under the Fifth Republic, uses the electoral-college system for choosing senators.

Balloting

Balloting, the actual process of voting, may be done in a variety of ways. The secret ballot has become almost universal, but in the past choice was expressed publicly by a show of hands, by standing up, by announcing one's vote aloud, or by dropping colored balls into a container. The paper ballot is still widely used, but special precautions are taken to assure secrecy. During most of the 19th century in the United States, political parties printed their own ballots on paper of different colors and shapes so they could be identified as they were dropped into the ballot box. These ballots invited intimidation of voters and encouraged corruption through vote buying. Eventually, the individual states adopted the Australian ballot, so called because it had been used in Victoria state, Australia. The purpose of the Australian ballot is secrecy and honesty in voting. The law requires that the ballot be printed or prepared at public expense and, if printed on paper, be of uniform size and color. It must list all candidates legally entitled to have their names included and must be distributed or available only at polling places where the voting is done in private booths.

In the United States paper ballots have been largely replaced by voting machines. Votes are cumulated on the machines, and when the voting is completed, the totals can be read off. Some U.S. districts have introduced electronic balloting, in which voters mark cards that are run through a machine for rapid counting. Although voting machines furnish no tangible evidence of the voters' intentions beyond the recorded totals, electronic voting permits the ballots to be examined and recounted in case of a dispute.

Voting Turnout

There are national differences in voter turnout—the percentage of eligible voters who actually vote. Several Western European countries tend to have larger turnouts than the United States, where the national average of citizens voting is not substantially greater than 50% of voting-age persons. Compulsory voting has been introduced in some countries, including Australia, Belgium, and Ecuador. Those who fail to vote must pay a fine, and chronic nonvoters may be disenfranchised.

See also: APPORTIONMENT; DEMOCRACY; PRESIDENTIAL ELECTIONS; REFERENDUM AND INITIATIVE.

election, primary see PRIMARY ELECTION

electoral college [ee-lek'-tohr-ul] The electoral college is the body that elects the presidents and vice-presidents of the United States. Article 2, Section I, of the U.S. Constitution provides that each state "shall appoint" as many presidential electors as the state has members of Congress. Three is the smallest number of electors a state may have, since every state has two senators and at least one member of the House of Representatives. The 23d Amendment to the U.S. Constitution, ratified in 1961, gave the District of Columbia three electoral votes. The Constitution gives the legislature of each state the authority to decide how that state's presidential electors are chosen, and every state has provided that the electors shall be directly elected by the voters.

After the electors have been chosen, they meet in their respective state capitals to cast their ballots. The only constitutional restriction is that an elector may vote for only one candidate who is a resident of the same state as that of the elector; this reflects the original assumption that the electors would exercise a choice.

The 12th Amendment to the U.S. Constitution, ratified in 1804, provides that electors should vote separately for the president and vice-president. To be elected president or vice-president, a candidate must receive a majority of all the electoral votes cast. If no candidate receives a majority, the House of Representatives chooses the president from among the three candidates receiving the highest number of electoral votes. For this purpose each state has one vote; for the House to make a choice, a majority of states must agree on one candidate. When no candidate for vice-president receives a majority, the Senate chooses the vice-president from the two highest candidates. Each senator has one vote; to win, a candidate must receive a majority of the votes cast in the Senate.

In practice the presidential electors are chosen through the political parties. Each party in each state nominates a slate of presidential electors for that state. This means that the voters choose one party's slate over another's. The result is that one party wins all or none of a state's electoral votes. (The electors are expected to vote for their own party's presidential and vice-presidential candidates, although occasionally an elector has voted for someone else.) The choosing of electors by slates makes it difficult for a third party to challenge the major parties unless it has strength in a number of states.

Proposals have been made to change the method of electing presidents and vice-presidents. One proposal is to replace the electoral college with a direct popular vote. A second is to give each party the same proportion of a state's electoral vote that it receives of the state's popular vote. A third is to elect individual presidential electors in each congressional district and two electors-at-large in each state.

Electra (mythology) [ee-lek'-truh] In Greek mythology, Electra was the daughter of AGAMEMNON, the king of Mycenae who was commander in chief of the Greeks in the TROJAN WAR, and his willful queen, CLYTEMNESTRA. Clytemnestra and her lover, Aegisthus, slew Agamemnon shortly after his return from the war, and Electra longed for the day when her brother, ORESTES, would avenge their father's death. When Orestes, who had been in hiding since his father's death, returned to Mycenae, he killed both Aegisthus and Clytemnestra with Electra's help. In this he was also aided by his close friend Pylades, whom Electra later married. Eventually, both Orestes and his sister were exonerated by ATHENA and the Eumenides, or FURIES.

Homer said little about Electra's role in this murder. Her story was elaborated in the plays of the 5th-century BC Athenian dramatists, especially Euripides and Sophocles.

Electra (play) see SOPHOCLES

electric car An electric car is an automobile powered by an electric motor that is run by batteries. The concept is not new; the essential BATTERY technology was developed in the late 19th century. Although some models achieved high speeds for that time, the electric car was generally relatively slow, heavy, and expensive to operate; its range was also limited by its dependence on facilities to recharge the battery. The use of the electric car diminished by about 1930 as the automobile gained in popularity.

Interest in the electric car revived after World War II with the development of smaller electric motors, more efficient batteries, and the fuel cell. Lighter materials also became available for the chassis of such automobiles. Car manufacturers were reluctant to develop the electric car, however, because of technical problems that had to be overcome. For example, the distance an electric car can travel before its batteries must be recharged is limited, although advances in battery technology may increase this range. On the other hand, the electric car is mechanically more dependable and durable than the gasoline-powered car, and it does not pollute the atmosphere.

An attempt to dispense with batteries altogether—and, in fact, to design an electric-powered car without transmission, gears, or a drive shaft—shows greater promise. In this "hybrid" system, the main source of power is a gasoline-driven generator that powers small, electric motors mounted behind each wheel.

electric circuit see CIRCUIT, ELECTRIC

electric current see CIRCUIT, ELECTRIC; ELECTRICITY

electric eye see PHOTOELECTRIC CELL

electric fish Electric fish are any of some 500 species of fishes that have specialized organs for the production of pronounced electric discharges. Such fishes depend on their electric organs for prey capture, protection, and navigation.

Notable electric fishes include the electric rays and skates, the electric eel, the elephant fishes, the stargazers, and certain catfishes. In most electric fishes, the electric discharge is of low voltage and is emitted continually in a series of pulses. However, the electric eel, *Electrophorus electricus*, is capable of producing an electric field of more than 600 volts (at one ampere), which is intense enough to kill small animals and stun large animals or humans. Marine electric rays of the genera *Narcine* and *Torpedo* can generate electric potentials as high as 220 volts, although the voltage usually ranges from 50 to 60 volts (at 50 amperes).

electric furnace An electric FURNACE is a round, deep receptacle lined with refractory brick, in which electrical energy is used to produce high temperatures in order to change or manufacture certain materials. By far the most important type is the arc furnace, in which scrap iron, called the *charge*, is heated to extreme temperatures to produce steel. Massive electrodes—some up to 7.3 m (24 ft) in length—are placed in contact with the scrap charge. Electrical energy (the arc) travels through the electrodes to the charge, and the arc temperature gradually grows high enough to melt the charge (see IRON AND STEEL INDUSTRY). The amount of electricity consumed per ton of steel produced is considerably less than that required to make steel from iron ores in an "integrated" plant.

In the steel industry electric arc furnaces are called "minimills," because they are far smaller than integrated mills. Giant minimills can produce up to 400 tons of steel at a single heat. More than one-third of the steel made in the United States is the product of electric furnaces.

Indirect arc furnaces heat a charge with an arc generated above the charge between the electrodes. In a resistor furnace, electric current passes through resistance-heating coils surrounding the charge. These, and other types of electric furnaces, are used to anneal materials such as glass, to liquefy plastic, and to heat-treat many different kinds of substances.

electric power generation see POWER, GENERATION AND TRANSMISSION OF

electrical and electronic engineering Electrical ENGINEERING is concerned with the generation, distribution, and use of electric power. Its products include electric GENERATORS, TRANSFORMERS, and MOTORS. Electronic engineering, a related branch, is devoted to the processing, communication, and storage of information by electronic means. Representative products of this branch include COMPUTERS, TELEPHONE systems, and SOUND RECORDING AND REPRODUCTION equipment; among its active subspecialties are communication systems, computation, and control systems.

History and Current Status. A series of inventions and discoveries in the mid-19th century, including ELECTROMAGNETIC INDUCTION, the TELEGRAPH, the telephone, and the INCANDESCENT LAMP, created the first demand for electrical engineers. More recent advances have included the ELECTRON TUBE, the RADIO and TELEVISION industries, computer technology, the TRANSISTOR, and MICROELECTRONICS.

In the early 1990s the Institute of Electrical and Electronic Engineers, a professional society, had a membership of 275,000. These engineers are employed in the research, development, application, manufacture, and marketing of electrical and electronic products. Most workers in this field have a college degree in electrical and electronic engineering.

Significance. The visible products of this field, although impressive, do not give an accurate indication of its pervasiveness. A true measure can be gained only by including the many creations a person ordinarily never sees, such as the controls in a jet aircraft or the instruments in a medical laboratory; computerization has infiltrated almost all areas of human activity in industrialized nations. One of the leading fields of so-called high technology today, microelectronics, has also become a focus of international debate, as nations such as the United States and Japan find themselves increasingly in competition for the development and manufacture of advanced devices.

electrical system, automotive see IGNITION SYSTEM

electrical wiring Electrical wiring is designed to carry electricity from a main electric supply source to a central point within a house or building and to channel it, via a system of electric circuits (see CIRCUIT, ELECTRIC), from there to every area that requires current. In most modern homes electricity is brought in from the main power supply through a transformer that reduces the power voltage from a higher transmission voltage to 240 volts. The current is led through an exterior "service head" and a meter that measures power consumption to a central service panel within the house. There the current is divided into separate circuits comprising heavy cables that are strung within walls and ceilings and to which power access is provided through wall and ceiling outlets. One circuit may provide the full 240 volts to a single outlet—that for a clothes dryer, for example; or it may supply 120-volt power to the outlets for one room or for an entire level in a house. The number of outlets on any one circuit, however, is usually restricted to a maximum of eight.

The service panel contains switches (see SWITCH, ELECTRIC) or fuses that can be used to shut off all incoming power. The panel also houses a separate FUSE or circuit breaker for each circuit. Should a circuit become overloaded—as it will, for example, if too many appliances draw current from it simultaneously—the fuse or circuit breaker will break the circuit before the circuit wire can become hot enough to start a fire.

Grounding—which is necessary to protect the system from the effects of lightning, faulty insulation, or other defects—is provided through a wire that connects the service panel to a rod or a water-supply pipe leading into the ground. All circuits are grounded to special grounding terminals in the service panel. Newer appliances are then connected to the grounding system with three-pronged plugs, which include grounding prongs.

The type of electric cable used and the methods of installation should follow the specifications of the National Electric Code, supplemented by mandatory local building codes.

Electrical Workers, International Brotherhood of The International Brotherhood of Electrical Workers is a union of skilled electrical workers and technicians. Since its founding in 1891, the IBEW has grown to become one of the largest U.S. labor unions, with about 1 million members. Originally called the National Brotherhood of Electrical Workers, the union took its present name when the first Canadian local union was established in 1899. Because it is a union of skilled workers, the IBEW has faced jurisdictional challenges from other unions seeking to organize less-skilled electrical workers. It is an affiliate of the AFL–CIO.

electricity Electricity is a form of ENERGY, a phenomenon that is a result of the existence of electrical charge. The theory of electricity and its inseparable effect, MAGNETISM, is probably the most accurate and complete of all scientific theories. The understanding of electricity has led to the invention of motors, generators, telephones, radio and television, X-ray devices, computers, and nuclear-energy systems.

Electric Charge

Amber is a yellowish, translucent mineral. As early as 600 BC the Greeks were aware of its peculiar property: when rubbed with a piece of fur, amber develops the ability to attract small pieces of material such as feathers. For centuries this strange, inexplicable property was thought to be unique to amber.

Two thousand years later, in the 16th century, William GILBERT proved that many other substances are electric (from the Greek word for amber, *elektron*) and that they have two electrical effects. When rubbed with fur, amber acquires resinous electricity; glass, however, when rubbed with silk, acquires vitreous electricity. Electricity repels the same kind and attracts the opposite kind of electricity. Scientists thought that the friction actually created the electricity (their word for charge). They did not realize that an equal amount of opposite electricity remained on the fur or silk.

In 1747, Benjamin FRANKLIN in America and William Watson (1715–87) in England independently reached the same conclusion: all materials possess a single kind of electrical "fluid" that can penetrate matter freely but that can be neither created nor destroyed. The action of rubbing merely transfers the fluid from one body to another, electrifying both. Franklin and Watson originated the principle of conservation of charge, which states that the total quantity of electricity in an insulated system is constant.

Franklin defined the fluid, which corresponded to vitreous electricity, as positive and the lack of fluid as negative. Therefore, according to Franklin, the direction of flow was from positive to negative—the opposite of what is now known to be true. A subsequent two-fluid theory

(Above) *Charles Augustin de Coulomb, an 18th-century French physicist, developed a torsion balance to measure the force between two electrical charges.* (Left) *Benjamin Franklin demonstrated the electrical nature of lightning by flying a kite into a storm cloud and drawing sparks from a key tied to the string.*

was developed, according to which samples of the same type attract, whereas those of opposite types repel.

Lightning. Franklin was acquainted with the Leyden jar, a glass jar coated inside and outside with tinfoil. It was the first capacitor, a device used to store charge. The Leyden jar could be discharged by touching the inner and outer foil layers simultaneously, causing an electrical shock to a person. If a metal conductor was used, a spark could be seen and heard. Franklin wondered whether lightning and thunder were also a result of electrical discharge. During a thunderstorm in 1752, Franklin flew a kite that had a metal tip connected to a silk string that acted as a conductor. A key was attached to the string at a point near the ground. The result was unmistakable: when Franklin touched the key it sparked and he could feel the electricity. The next two who tried this extremely dangerous experiment were killed.

The Electrical Force. It was known as early as 1600 that the attractive or repulsive force diminishes as the charges are separated. This relationship was first placed on a numerically accurate, or quantitative, foundation by Joseph Priestley, a friend of Benjamin Franklin. In 1767, Priestley indirectly deduced that when the distance between two small, charged bodies is increased by some factor, the force between the bodies is reduced by the square of the factor. For example, if the distance between charges is tripled, the force decreases to one-ninth its former value. Although rigorous, Priestley's proof was so simple that he did not strongly advocate it. The matter was not considered settled until 18 years later, when John Robinson of Scotland made more direct measurements of the electrical force involved.

Coulomb's Law. The French physicist Charles A. de Coulomb, whose name is used as the unit of electrical charge, later performed a series of experiments that added important details, as well as precision, to Priestley's proof. He also promoted the two-fluid theory of electrical charges, rejecting both the idea of the creation of electricity by friction and Franklin's single-fluid model.

Today the electrostatic force law, also known as Coulomb's law, is expressed as follows: If two small objects, a distance r apart, have charges q_1 and q_2 and are at rest, the magnitude of the force (F) on either is given by $F = kq_1q_2/r^2$, where k is a constant. According to the International System of Units (see units, physical), the force is measured in newtons (1 newton = 0.225 lb), the distance in meters, and the charges in coulombs. The constant k then becomes 8.988 x 10^9. Charges of opposite sign attract, whereas those of the same sign repel (see electrostatics).

A coulomb (C) is a large amount of charge. To hold a positive coulomb (+ C) 1 meter away from a negative coulomb (– C) would require a force of 9 x 10^9 newtons (2 billion pounds). A typical charged cloud about to give rise to a lightning bolt has a charge of about 30 coulombs.

Electric Potential

Because of an accident the 18th-century Italian scientist Luigi Galvani started a chain of events that culminated in the development of the concept of voltage and the invention of the battery. In 1780 one of Galvani's assistants noticed that a dissected frog's leg twitched when he touched its nerve with a scalpel. Another assistant thought that he had seen a spark from a nearby charged electric generator at the same time. Galvani reasoned that the electricity was the cause of the muscle contractions. He mistakenly thought, however, that the effect was due to the transfer of a special fluid, or "animal electricity," rather than to conventional electricity.

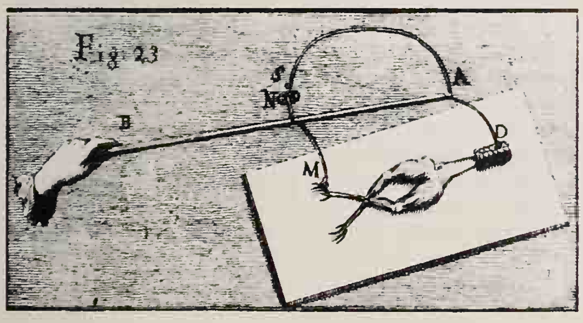
The Battery. In experimenting with what he called atmospheric electricity, Galvani found that a frog muscle would twitch when hung by a brass hook on an iron lattice. Another Italian, Alessandro VOLTA, a professor at the University of Pavia, affirmed that the brass and iron, separated by the moist tissue of the frog, were generating electricity, and that the frog's leg was simply a detector. In 1800, Volta succeeded in amplifying the effect by stacking plates made of copper, zinc, and moistened pasteboard respectively and in so doing he invented the BATTERY.

A battery separates electrical charge by chemical means. If the charge is removed in some way, the battery separates more charge, thus transforming chemical energy into electrical energy. A battery can affect charges, for instance, by forcing them through the filament of a light bulb. Its ability to do work by electrical means is measured by the VOLT, named for Volta. A volt is equal to 1 JOULE of work or energy (1 joule = 2.78×10^{-7} kilowatt-hour) for each coulomb of charge. The electrical ability of a battery to do work is called the ELECTROMOTIVE FORCE, or emf.

The Capacitor. Another device capable of electrical work is the capacitor, a descendant of the Leyden jar, which is used to store charge. If a charge Q is placed on the metal plates the voltage rises to amount V. The measure of a capacitor's ability to store charge is the capacitance C, where $C = Q/V$. Charge flows from a capacitor just as it flows from a battery, but with one significant difference. When the charge leaves a capacitor's plates, no more can be obtained without recharging. This happens because the electrical force is conservative. The energy released cannot exceed the energy stored. This ability to do work is called electric POTENTIAL.

Alessandro Volta, a 19th-century Italian physicist, found that he could get electricity from a voltaic cell consisting of two dissimilar metals in salt water. He devised a voltaic pile (right), *the first practical battery, by connecting many voltaic cells.*

(Left) *Luigi Galvani, an 18th-century physiologist, became famous as a comparative anatomist but is best remembered for his work on the action of electricity on the legs of frogs.* (Below) *He found that he could cause contraction by using wires made of different metals and contacting them after attaching one to a muscle and one to a nerve.*



A type of conservation of energy is also associated with emf (see CONSERVATION, LAWS OF). The electrical energy obtainable from a battery is limited by the energy stored in chemical molecular bonds. Both emf and electric potential are measured in volts, and, unfortunately, the terms *voltage, potential*, and *emf* are used rather loosely. For example, the term *battery potential* is often used instead of emf.

Voltage. Whether as an emf or an electric potential, voltage is a measure of the ability of a system to do work on a unit amount of charge by electrical means. Voltage is a better-known quantity than electric field. For instance, voltages measured in an electrocardiogram peak at 5 millivolts; many are familiar with the 115-volt potential of a house electrical system. The potential between a cloud and the ground just before a typical lightning bolt is a minimum of 10,000 volts. Devices for developing or changing potential or emf include batteries, GENERATORS, TRANSFORMERS, and Van de Graaff generators.

Sometimes high voltages are needed. For instance, the electron beams in television tubes require more than 30,000 volts. Electrons "falling" through such a potential reach velocities as high as one-third the speed of light and have sufficient energy to cause a spot of light on the screen. Such high potentials may be developed from lower alternating potentials by using a transformer.

By scuffing shoes on a carpet on a dry day, an electric potential of more than 20,000 volts can be developed, resulting in a spark.

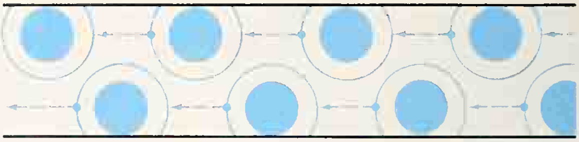
Electric Current

An electric charge in motion is called electric current (see CIRCUIT, ELECTRIC). The strength of a current is the amount of charge passing a given point (as in a wire) per second, or $I = Q/t$, where Q coulombs of charge pass in t seconds. The unit for measuring current is the AMPERE or amp, which equals 1 coulomb/sec.

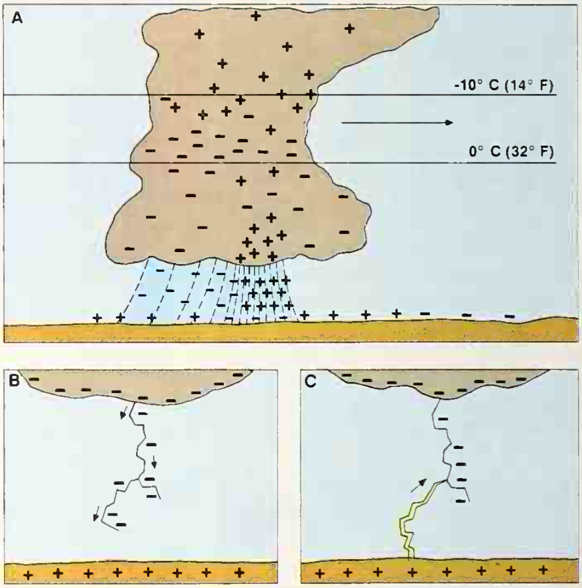
Because it is the source of magnetism as well, current is the link between electricity and magnetism. In 1819 the Danish physicist Hans Christian Oersted found that a compass needle was affected by a current-carrying wire. Almost immediately, André AMPÈRE in France discovered the magnetic force law. Michael FARADAY in England and Joseph HENRY in the United States added the idea of magnetic induction, whereby a changing magnetic field produces an electric field. The stage was then set for the encompassing electromagnetic theory of James Clerk MAXWELL (see ELECTROMAGNETIC RADIATION).

The range of actual currents is enormous. A modern electrometer can detect currents as low as 10^{-17} amp, which is a mere 63 electrons per second. The current in a nerve impulse is approximately 10^{-5} amp; a 100-watt light bulb carries 1 amp; a lightning bolt peaks at about 20,000 amps; and a 1,200-megawatt nuclear power plant can deliver 10,000,000 amps at 115 V.

Most materials are INSULATORS. In them, all electrons are bound in individual atoms and do not permit a flow of charge unless the electric field acting on the material is so high that breakdown occurs. Then, in a process called ionization (see ION AND IONIZATION), the most loosely bound electrons are torn from the atoms, allowing current flow. This condition exists during a lightning storm. The separation of charge between the clouds and the ground creates a large electric field that ionizes the air atoms, thereby forming a conducting path from cloud to ground.



(Above) *An electric current consists of a stream of electrons that flows through a wire from a region of negative potential to a region of positive potential at a different level.*



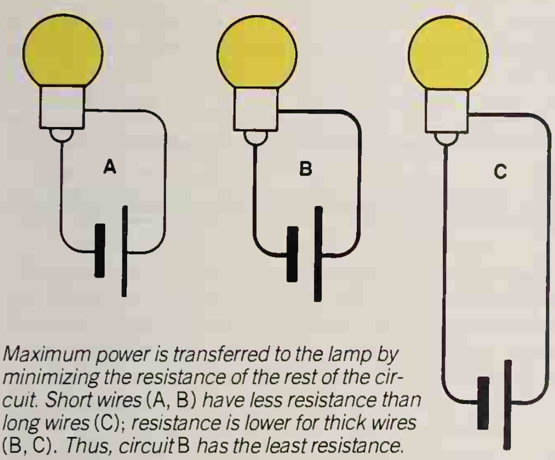
Lightning, an awesome display of natural electricity, is the result of a potential difference between a cloud and the ground (A). *A stroke starts with a small lightning discharge called a step leader, which moves toward Earth in a series of steps* (B). *When the leader reaches the ground, the negative discharges drain rapidly and a so-called return-stroke discharge moves back up the path followed by the step leader* (C). *The return stroke is the thunderbolt that is actually seen and heard; it is estimated to produce about 10,000 amperes.*

Resistance. Although a conductor permits the flow of charge, it is not without a cost in energy. The electrons are accelerated by the electric field. Before they move far, however, they collide with one of the atoms of the conductor, slowing them down or even reversing their direction. As a result, they lose energy to the atoms. This energy appears as heat, and the scattering is a resistance to the current.

In 1827 a German teacher named Georg Ohm demonstrated that the current in a wire increases in direct proportion to the voltage V and the cross-sectional areas of the wire A, and in inverse proportion to the length l. Because the current also depends on the particular material, Ohm's law is written in two steps, $I = V/R$, and $R = \rho l/A$. The quantity R is called the RESISTANCE, and ρ, which depends only on the type of material, is the RESISTIVITY. The unit of resistance is the OHM, where 1 ohm is equal to 1 volt/amp.

In lead, a fair conductor, the resistivity is 22×10^{-8} ohmmeters; in copper, an excellent conductor, it is only

George Ohm, a 19th-century German physicist, discovered the law that relates the resistance of a circuit to its current and its voltage.



Maximum power is transferred to the lamp by minimizing the resistance of the rest of the circuit. Short wires (A, B) *have less resistance than long wires* (C); *resistance is lower for thick wires* (B, C). *Thus, circuit* B *has the least resistance.*

Robert A. Millikan was an outstanding American experimental physicist. A pioneer and a leading authority in the study of cosmic rays, he was also the first to determine the charge of the electron.

1.7 x 10^{-8} ohmmeters. Where high resistances between 1 and 1 million ohms are needed, RESISTORS are made of materials such as carbon, which has a resistivity of 1400 x 10^{-8} ohmmeters. Certain materials, such as lead, lose their resistance almost entirely when cooled to within a few degrees of absolute zero. Such materials are called superconductors (see SUPERCONDUCTIVITY). Substances have recently been found that become superconductive at much higher temperatures.

The resistive heating caused by electron scattering is a significant effect and is used in electric stoves and heaters as well as in incandescent light bulbs. In a resistor the power P, or energy per second, is given by $P = I^2R$.

Speed of Electricity. As electrons bounce along through the wire, the general charge drift constitutes the current. The average, or drift, speed is defined as the speed the electrons would have if all were moving with constant velocity parallel to the field. The drift speed is actually small even in good conductors. In a 1.0-mm-diameter copper wire carrying a current of 10 amps at room temperature, the drift speed of the electrons is 0.2 mm per second. In copper, the electrons rarely drift faster than 10^{-11} (one hundred-billionth) the speed of light. On the other hand, the speed of the electric signal *is* the speed of light. This means that, at the speed of light, the removal of one electron from one end of a long wire would affect electrons elsewhere.

For example, consider a long, motionless freight train, with the cars representing electrons in a wire. Because the couplings between cars have play in them, the caboose is affected a short while after the engine begins moving. During this time the engine moves forward a short distance. The signal telling the caboose to start moves backward quickly, traveling the length of the train in the same time it takes the engine to go forward a meter or so. Similarly, the electron drift speed in a conductor is low, but the signal moves at the speed of light in the opposite direction.

Electrical Theory of Matter

A great deal of evidence had to be accumulated before the view was accepted that electricity comes in tiny, discrete amounts, looking not at all like a fluid when viewed microscopically. Toward the end of the 1800s the work of Sir Joseph John THOMSON and others proved the existence of the ELECTRON. Thomson had measured the ratio of the electron's charge to its mass. Then in 1899 he inferred a value for the electronic charge itself by observing the behavior of a cloud of tiny, charged water droplets in an electric field. This observation led to MILLIKAN'S OIL-DROP EXPERIMENT in 1906, in which he determined that the electron charge e is negative and has the value $e = 1.60 \times 10^{-19}$ coulombs. This charge is so small that a single copper penny contains more than 10^{22} electrons.

In 1911, Ernest RUTHERFORD proposed the nuclear ATOM. He suggested that electrons orbit a positively charged nucleus less than 10^{-14} meters in diameter, just as planets orbit the Sun. Rutherford also suggested that the nucleus is composed of PROTONS, each having a charge $+e$. This view of matter, still considered correct in many ways, established the electrical force as that which holds an atom together. After Rutherford presented his

Murray Gell-Mann, a leading American physicist, is best known for his work on quantum field theory and elementary atomic particles. He was awarded the 1969 Nobel Prize for physics for his theory of quarks and the "eightfold" way, which is concerned with the formation of elementary particles in the atomic nucleus.

atom, the Danish physicist Niels BOHR proposed that the electrons have only certain orbits about the nucleus, and that other orbits are impossible, the beginnings of QUANTUM MECHANICS.

Unanswered Problems

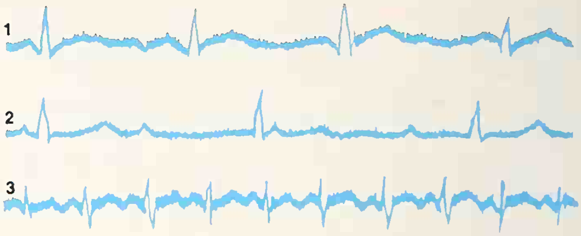
In spite of many spectacular successes, important unanswered questions remain within the field of electricity. The question of how electric force is transmitted is part of the theory of QUANTUM ELECTRODYNAMICS, a theory that still has many puzzling aspects. What holds the electron together is still widely debated, and there are questions involving FUNDAMENTAL INTERACTIONS.

See also: ELECTROMAGNETIC RADIATION.

electrocardiograph An electrocardiograph is a device for recording the electrical activity of the muscles of the HEART. The recording is called an electrocardiogram (abbreviated EKG or ECG). The technique itself is known as electrocardiography. In 1900, Willem Einthoven invented the first practical electrocardiograph. For his work he received the 1924 Nobel Prize for physiology or medicine. Contrary to a widespread conception, the EKG is not a measurement of the actual muscular activity of the heart. What is measured is the flow of ions (or electrical current) through the membranes of the heart muscle before muscular contraction.

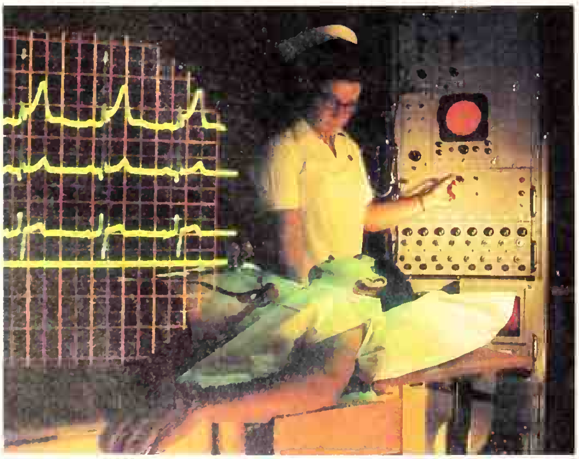
It is possible to obtain a normal electrical reading from a heart that has stopped beating, although normally the electrical activity is followed by appropriate muscular activity. The electrical activity is detected by amplifiers connected to leads on the limbs and chest and recorded by a recording device or by an oscilloscope.

To be of true diagnostic value, an EKG is also taken when a patient is exercising. EKGs taken during exercise can reveal a discrepancy between the blood supply and the oxygen requirements of the heart muscle. Developments in electroencephalography include multilead spatial EKGs, in which a computer and imaging techniques are used to construct a three-dimensional model of the spread of electrical excitation across the heart. Such readings reveal areas of dead or dying muscle. An EKG can be transmitted; thus, an outpatient may be connected to an electrocardiograph in a hospital. EKGs of people under stress show that the heart rate and the amount of oxygen required by the heart may rise so much that the circulatory system is unable to meet the demand.



A normal electrocardiogram (1) is shown above. The EKG of a patient with a complete heart block (2) reveals a very slow contraction rate of the ventricles, as indicated by the increased distance between the tall spikes known as R waves. A pattern with a normal form but a faster rate (3) often results from fever or emotional excitement.

A patient is attached to an electrocardiograph by means of electrodes placed on the chest. The reading obtained, called an electrocardiogram (EKG), may be displayed on a screen or recorded on a printout. Changes in electrical activity in the patient's heart appear as waves.



electrochemical equivalent see ELECTROCHEMISTRY

electrochemical series see ELECTROMOTIVE SERIES

electrochemistry Electrochemistry is the study of the production or use of electric current by the chemical reactions of electrolytes. An electrolyte is a substance that, when dissolved in a suitable solvent or melted, forms a medium that conducts electric current. Electrochemical reactions take place when electrodes are inserted into an electrolyte medium and a current is passed.

Electric current is generated by chemical reactions in BATTERIES, the first of which was constructed in 1800 by Alessandro Volta (see ELECTRICITY). ELECTROLYSIS is the process in which electric current drives the occurrence of a chemical reaction; it has many practical applications, especially in METALLURGY, and was used in 1807 by Sir Humphry DAVY in the discovery of sodium and potassium.

The Electrochemical Reaction

When an electrolyte is dissolved in water, the solution conducts electricity. The conductance is explained in terms of three processes. First, the charge is transferred through the bulk of the solution by the migration of positive and negative ions to the electrode of opposite charge. Second, a reaction occurs at the negative electrode, which allows electrons to flow into the electrode from an outside source and be consumed there. Third, a reaction occurs at the positive electrode, producing electrons that can flow into the external circuit. In a broader sense, the electrochemical reaction is not limited to aqueous systems. A molten salt such as sodium chloride can serve as the electrolytic medium between the electrodes.

In any electrochemical process, whether it is a spontaneous process that generates a current through an external circuit (voltaic or galvanic cell), or a nonspontaneous process that is driven by an external power source (electrolytic cell), the net chemical reaction is the sum of the two half-cell reactions that occur at the electrodes. One of these reactions is always an oxidation reaction in which the chemical species loses electrons, whereas the other is a reduction reaction in which the active species gains electrons (see OXIDATION AND REDUCTION). For example, in the electrolysis of molten sodium chloride, NaCl, to produce sodium metal, Na, and chlorine gas, Cl_2, the half reactions are

cathode reaction	$Na^+ + e^- \rightarrow Na$
anode reaction	$Cl^- \rightarrow \frac{1}{2}Cl_2 + e^-$

Laws of Electrolysis

In 1834, Michael FARADAY provided a quantitative explanation for electrolysis. The first of Faraday's laws of electrolysis states that the amount of product formed is proportional to the amount of electricity that has flowed through an electrolytic cell. For example, in the electrolysis of molten sodium chloride, the more electrons that flow, the more sodium will be produced.

Faraday's second law states that the mass of a substance liberated by a given amount of electricity is proportional to the equivalent weight of the substance. The equivalent weight of a metal in an electrochemical reaction is the gram ATOMIC WEIGHT of the metal divided by the charge on the positive ion of that metal. For sodium with a +1 charge, one gram equivalent weight equals one gram atomic weight; for zinc, with a +2 charge in Zn^{2+}, it equals one-half the gram atomic weight. The quantity of electricity associated with one mole (see MOLE, unit of substance) of electrons is called the faraday and equals about 96,489 COULOMBS. One faraday of electricity produces one electrochemical equivalent of product at each electrode. In electrolysis, therefore, one faraday will produce 23 grams (one mole) of sodium from Na^+ or 33 grams (one-half mole) of zinc from Zn^{2+}.

Development of Modern Electrochemistry

Josiah Willard GIBBS demonstrated (1875) that chemical forces are quantitatively measured by the voltages of operating cells. Walther NERNST followed in 1889 with studies of equilibrium that related cell potential to the concentration of chemicals making up the cell. Svante ARRHENIUS built on Faraday's ideas by explaining (1887) the electrical conductance of solutions in terms of migrating ions and equilibria between ions and molecules. In 1923, Peter DEBYE and Erich Hückel explained conductance, electrochemical potential, and other properties of ionic solutions.

Intensive efforts are being made to understand the electrical double layer that always occurs at the interface where dissimilar materials make contact. The double layer consists of two oppositely charged sheets of fluid facing each other. An understanding of that structure is thought to be the key to an explanation of all electrochemical events.

Modern Methods

When two electrodes are separated by a conducting liquid, the chemical composition of the system can be determined by measuring one of the following parameters while holding constant one or more of the others: electrical potential (voltage); charge transferred (coulombs); current (coulombs per second); and time. The measurement techniques include coulometry, potentiometry, and amperometry.

Coulometry. The amount of chemical reacting at an electrode is measured in coulombs of charge that pass the electrode's surface. Ideally, the potential is set to allow one chemical reaction and exclude others. Thus, for example, silver can be plated from a copper solution at a potential large enough to provoke silver reduction but not large enough to reduce the copper.

Potentiometry. The equilibrium potential of an electrochemical cell is measured at zero current. Any two electrodes not identical in composition produce an electrical potential when they are connected through a conducting liquid. The potential has considerable theoretical significance. It is a function of the equilibrium constant for the chemical reaction involved, the concentrations of the chemicals involved, and the temperature.

Although chemicals can sometimes be identified by a potentiometer, this technique is used mainly to measure the concentration of chemical species as a function of electrode potentials. Numerous specific ion electrodes have been developed, in the manner of the classic pH glass electrode, for measuring a wide variety of chemicals—from pollutants introduced into water to specific biochemicals in living systems.

Amperometry. The current that flows through a microelectrode at a constant potential is a measure of the concentration of the species that is carrying a charge to or away from the electrode. In voltametry, the current is measured as the potential is varied. The potential at which the current changes reflects the identity of the species, and the amount of the current measures its concentration.

Polarography involves the measurement of current at a constantly dropping mercury microelectrode as the electrode is polarized, either positively or negatively relative to a selected reference potential. Polarography has been widely used, both in theoretical studies and in practical analysis.

electrocution Electrocution is a method of executing criminals with electricity, often used in the United States but seldom elsewhere. The condemned person is seated in a chair, and electrodes are attached to the head and one leg, making the body a conductor for about 5 amperes of current at 2,000 volts. The voltage is lowered and raised several times, with death resulting in less than 3 minutes. The electric chair was first used at Auburn State Prison, N.Y., in 1890 and for a while became the customary CAPITAL PUNISHMENT in 24 states. Fewer states now use it, however, as lethal injection becomes more common.

electrode An electrode is a conductor or terminal, usually metallic, through which an electric current enters or leaves a device or an object. In applications such as ELECTROLYSIS and ELECTROPLATING, where the electrodes are connected directly to a source of DC (direct current) voltage, the positive electrode is known as the anode, and the negative electrode as the CATHODE. Modern methods for increasing the efficiency, selectivity, and durability of electrodes involve placing thin layers on their surfaces either by covalent anchoring or by chemical deposition. The discovery of conducting polymers has opened up a new field of versatile, polymeric electrodes.

electroencephalograph [ee-lek'-troh-en-sef'-uh-loh-graf] An electroencephalogram (EEG) is a recording of the electrical activity of the BRAIN, and an electroencephalograph is the instrument used to make the recording. The technique was first reported in 1929 by German psychiatrist Hans Berger.

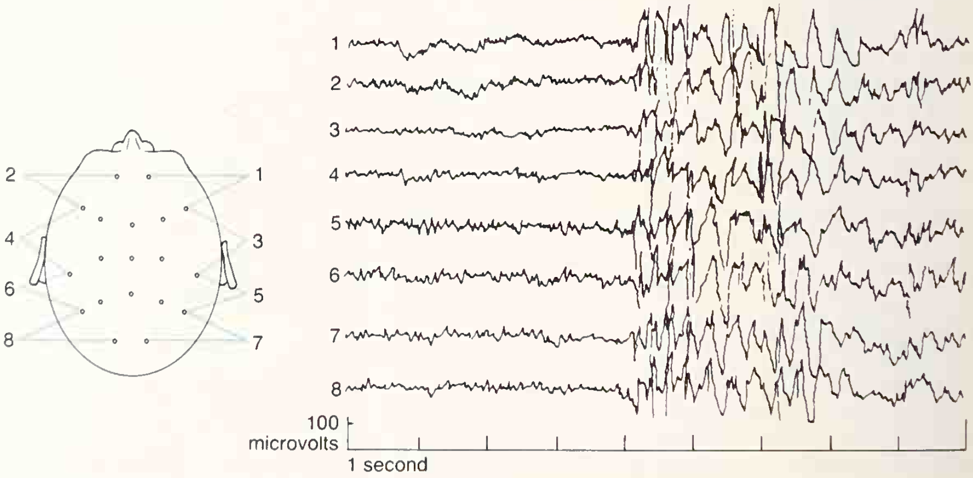
The nervous system of the human being contains about 100 billion (10^{10}) nerve cells. Most are located within the brain, with the remainder found in the spinal cord and distributed throughout the body in the connecting nerves. Each brain cell connects with 5,000 to 50,000 other nerve cells. Nerve impulses are carried along the nerve fibers and across these connections as a wave of electrical activity, which is coupled with certain chemical changes in the nerve cell and a reversal of polarity on the surfaces of the nerve cell. These changes in polarity and the electrical currents that are generated can be measured on the scalp. Electrodes placed on the scalp are connected to the electroencephalograph, which records on a sheet of paper the brain waves, or changing electrical potential of the nerve impulses in the brain.

Certain abnormal EEG patterns are associated with such ailments as epilepsy, stroke, and brain tumors. Thus, study of a patient's EEG can aid in diagnosis. The EEG can also provide a definition of brain death (see DEATH AND DYING).

electroglow Electroglow is an emission phenomenon that has been observed in the MAGNETOSPHERES of the outer planets. Present only on the sunlit sides of the planets, the glow is produced by the collision of electrons with molecular hydrogen. The electrons are freed from atoms by solar ultraviolet radiation, but the energy of the electroglow greatly exceeds that of the incoming radiation.

electroluminescence [ee-lek'-troh-loom-ines'-ens] Electroluminescence originally described the emission of light when an electric current passes through a gas. Today it refers to the production of nonincandescent light when an electric field is applied to a solid body. The latter phenomenon was first observed in silicon carbide. In recent years electroluminescence has become of great practical and commercial importance. It forms the basis for light-emitting diodes (LEDs) commonly employed as display elements in electronic equipment and digital watches.

electrolysis [ee-lek-trahl'-uh-sis] Electrolysis is the decomposition of a chemical substance caused by passing a direct electric current through it (see ELECTROCHEMISTRY). Applications include the decomposition of water,



The left half of this EEG is normal, but the right half indicates an epileptic attack. Such a seizure results from massive discharges by nerve cells in the brain; it appears on the trace as high-amplitude slow waves and sharp spikes. Each line of the EEG records the electrical activity at a different point of the brain, as transmitted by electrodes attached to corresponding positions on the scalp.

electroplating, industrial production of metals, and the charging of storage BATTERIES. In each case, electrical energy is converted to chemical potential energy and stored in the structure of the new chemicals. The term *electrolysis* is also applied to the destruction of hair roots by electric current.

Electrolysis of Water. Passage of an electric current through water containing some sulfuric acid results in decomposition of the water into its elements: hydrogen and oxygen. At the cathode, positively charged hydrogen ions are reduced to hydrogen gas. At the anode, water is oxidized to oxygen gas. The net cell reaction is the sum of the two half-cell reactions:

$$\begin{array}{ll} \text{cathode reaction} & 4H^+ + 4e^- \rightarrow 2H_2 \\ \text{anode reaction} & \underline{\quad 2H_2O \rightarrow 4e^- + O_2 + 4H^+} \\ & \quad 2H_2O \rightarrow 2H_2 + O_2 \end{array}$$

Metallurgy. Electrolysis is a useful means for isolating active metals from their compounds and ores (see METALLURGY). For very active metals such as sodium, which is produced by electrolysis of molten salt (NaCl), it is the only economic method. ALUMINUM is also produced by electrolysis, in this case of the aluminum oxide (Al_2O_3) first separated from the bauxite ore. Some metals, such as COPPER, are purified by electrolysis. Copper of more than 99.9% purity is produced by electrolytic refining of the impure metal obtained by chemical reduction of its ores.

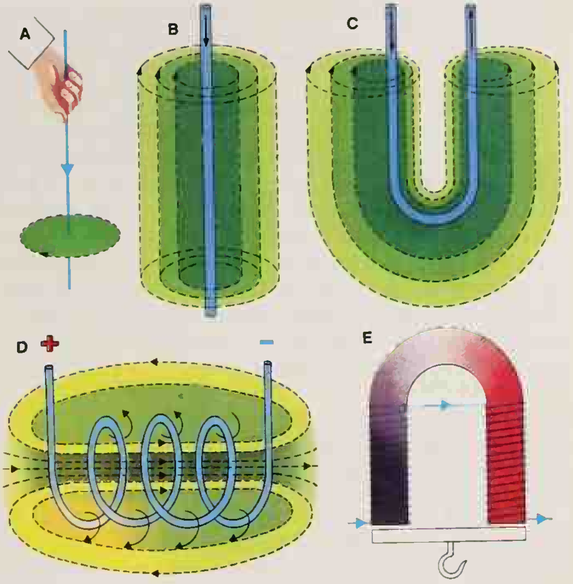
Electroplating. ELECTROPLATING is an electrolytic process in which the ions of a metal in solution are reduced and deposited onto the object to be plated. For example, a negatively charged spoon can be silverplated by reducing dicyanosilver ions, $Ag(CN_2)^-$, to metallic silver on its surface.

Other Uses. A major segment of the chemical industry relies on the electrolysis of concentrated salt (NaCl) solutions known as brines. Chlorine is liberated at the anode, and hydrogen plus an alkaline solution from which lye (NaOH) is made are liberated at the cathode.

electrolyte see ELECTROCHEMISTRY

electromagnet An electromagnet is a coil of wire, usually wound around an iron core, that produces magnetism as long as an electric current flows through the coil. Because electromagnets act like permanent MAGNETS, they are used to lift and load scrap iron. An electromagnet's magnetism, however, unlike a permanent magnet's, can be turned on and off, making it useful in operating electrical devices with movable magnetic parts, such as GENERATORS, MOTORS, brakes, clutches, relays, and solenoids. Electromagnets also have a wide range of scientific applications, such as the giant magnets used in particle ACCELERATORS at superconductive temperatures (see SUPERCONDUCTIVITY).

In the SOLENOID an iron core held away from the center of the coil is rapidly pulled into the center position when the coil is energized, completing the circuit. In the RELAY the coil is wound on (and insulated from) a stationary core. When current flows through the coil, the core becomes magnetized, causing a hinged, soft-iron armature located near the electromagnet to be attracted to it. As the armature moves, it makes or breaks a separate electric circuit. Relays are used in such devices as circuit breakers, doorbells, regulators, and telephone receivers.



A magnetic field exists around a wire carrying an electric current. If the wire is held in the right hand (A) *with the thumb pointing in the current's direction, the fingers curl in the field's direction. The field is symmetrical, whether the wire is straight* (B) *or curved* (C). *Its strength is increased if the wire is wound in a spiral, or solenoid* (D). *An electromagnet* (E) *with a strong magnetic field is obtained if the coil is wrapped around an iron core.*

electromagnetic induction Electromagnetic induction is the creation of an electric field by a time-varying magnetic field. The electric field may be produced, according to Faraday's law of induction, in two ways: by the motion of a conductor cutting across the lines of magnetic flux of a magnetic field, or by a change in the magnetic flux passing through a coil immersed in a nonconstant magnetic field. The most important result of electromagnetic induction is the occurrence of ELECTROMAGNETIC RADIATION.

electromagnetic pulse An electromagnetic pulse (EMP) is a brief, intense electromagnetic field that accompanies the detonation of nuclear weapons. The result of ionization of the Earth's atmosphere by radiation, EMP can propagate for thousands of kilometers and, with a peak strength of 50,000 volts per meter, can cause severe damage to sensitive electronic equipment.

U.S. scientists first became aware of EMP in the early 1960s, during high-altitude nuclear tests. Because most electronic equipment of that time was built with relatively insensitive electron tubes, the phenomenon had only minor effects. The rapid development and widespread use of sensitive semiconductor and integrated circuit devices, however, have radically altered the situation. It is now thought that a single high-altitude blast over the United States could seriously disrupt the nation's communications system, which is difficult to protect because of its great extent, and perhaps shut down the entire power grid.

Protective measures include the use of electron tubes instead of semiconductors, metal shielding for electronic components, redesign of circuit layouts, and employment of fiber optics systems, which are invulnerable to EMP. At present, however, there is no known way of providing complete protection against the effect.

electromagnetic radiation Electromagnetic radiation is the transmission of energy in the form of waves having both an electric and a magnetic component; a wave with just one of these components cannot exist. The forms of electromagnetic radiation are RADIO waves, INFRARED RADIATION, LIGHT waves, ULTRAVIOLET LIGHT, X RAYS, and GAMMA RAYS, all of which constitute the electromagnetic spectrum. All of these forms are essentially the same physical phenomenon, differing principally in the wave length and frequency of the radiation. All electromagnetic waves travel through empty space with the same velocity c, equal to 299,792 km/sec (186,291 mi/sec).

Electromagnetic Spectrum

Electromagnetic radiation is most simply characterized by its frequency ν or wavelength λ. When electromagnetic waves are ordered in accordance with their frequency or wavelength, this ordered array is called the electromagnetic SPECTRUM. A source of radiation, such as the Sun, a flame, an electrical discharge, or an incandescent solid, never produces just one frequency of electromagnetic wave, but rather emits a mixture of waves of many different frequencies. These spectra may be resolved, or separated, by such instruments as prisms or grating spectrometers.

In principle the electromagnetic spectrum extends from zero, the short-wavelength limit of the gamma-ray end of the spectrum, to infinity, the long-wavelength limit of the radio end of the spectrum. Visible light, the portion of the spectrum to which the eye is sensitive, occupies a narrow band extending from about 3.8×10^{-7} to 7.5×10^{-7} m. The colored components of this segment of the spectrum may be seen when a narrow beam of sunlight is passed through a glass prism to form a band of colors that extends from red at the long-wavelength end to violet at the short-wavelength end. The radiation dispersed by the prism actually extends farther in both directions, but the radiation outside of this range cannot be detected by the human eye.

Sources of Electromagnetic Radiation

The sources of electromagnetic radiation are accelerated electrical charges and oscillating currents. For example, the current that flows back and forth in the antenna of a radio transmitter radiates electromagnetic waves in the radio frequency part of the spectrum; these wavelengths lie in the range from a few centimeters to hundreds of meters. Similarly, the oscillatory motion of electrons in atoms and molecules radiates light waves with wavelengths that may be in the infrared region (10^{-3} to 10^{-6} m), the visible region, the ultraviolet region (3×10^{-7} to 10^{-10} m), or the X-ray region (10^{-8} to 10^{-11} m). The wavelength of the emitted radiation depends on the energy of the oscillations that give rise to it.

Visible and ultraviolet radiation arises when the outermost and least strongly bound electrons change their atomic energy levels. X rays are produced when atoms are bombarded by high-energy electrons that can strip a strongly bound electron from an orbit close to the nucleus. When an outer electron jumps into the vacancy, a high-energy PHOTON (the particle equated with radiation) with a wavelength in the X-ray region of the spectrum is emitted.

Gamma rays arise from transitions between energy levels of the nucleus. The nucleus is composed of protons and neutrons held together by nuclear forces that are much stronger than the electrical forces that bind the electrons in the atom. Because of the greater strength of the nuclear forces, the energy levels of the nucleus are widely separated, and the photons emitted as a consequence of nuclear transitions are more energetic than those emitted in atomic transitions. Gamma rays are also emitted in collisions between very high-energy charged particles, such as cosmic rays, colliding with nuclei of atoms of the atmosphere.

The energy levels associated with the rotational and vibrational motion of molecules are closely spaced. Therefore, the photons emitted in transitions between these levels have small energies, and their wavelengths lie in the infrared part of the spectrum. Also, infrared radiation is emitted from solids, because the energy levels associated with lattice vibrations are so closely spaced as to virtually form a continuum.

Radio waves are produced by coherent motion of electrons, such as the oscillatory current that flows in the antenna of a radio transmitter. Since the early days of radio, the ingenuity of engineers has continually pushed the useful range of radio wavelengths down until today the lower limit lies in the millimeter range (microwaves), where it overlaps with the infrared spectrum. Radio waves are also produced by charged particles orbiting in magnetic fields. This is the source of much of the radio-frequency radiation observed by radio astronomers. Another important source of astronomical radio-frequency radiation is a transition between two closely spaced energy levels in the hydrogen atom. In this transition the orientations of the spins of the electron and proton change from antiparallel to parallel with the emission of a photon with a wavelength of 21 cm.

The Electromagnetic Field

The theory of electromagnetic fields was developed by James Clerk MAXWELL of Scotland and published in 1865. His work was the culmination of a long series of experi-

James Clerk Maxwell, a Scottish theoretical physicist of the 19th century, made a number of contributions to astronomy, the kinetic theory of gases, and the theory of heat, but is best known for his work on electricity and magnetism. He demonstrated that light, electricity, and magnetism are related.

ments and theoretical research performed by numerous illustrious scientists, including William GILBERT, Benjamin FRANKLIN, Charles Augustin de COULOMB, André AMPÈRE, Georg Ohm, and Michael FARADAY. (For a history of the development of electromagnetic theory, see ELECTRICITY.)

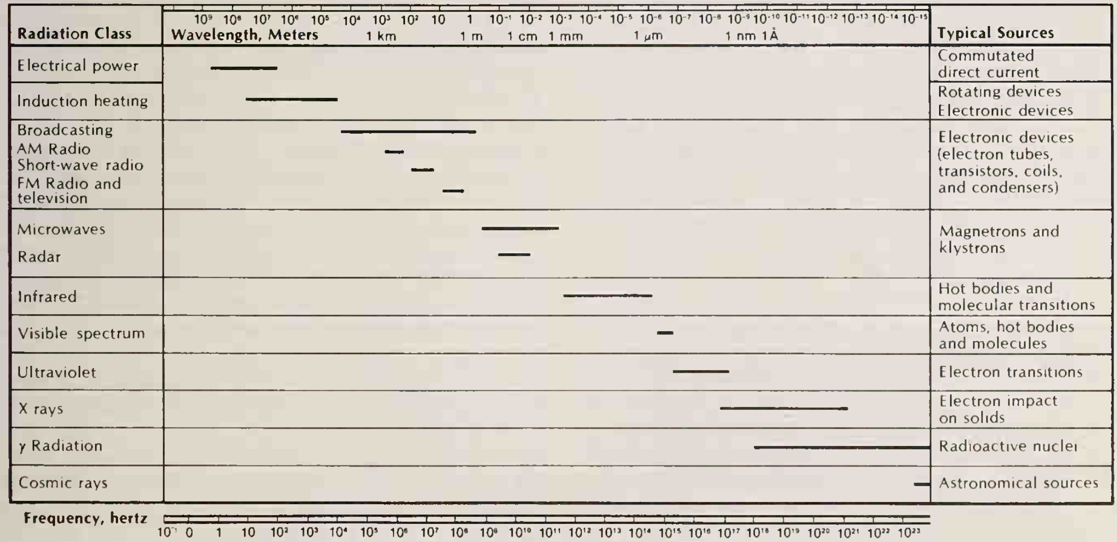
Maxwell presented a set of equations that completely describe the electromagnetic field, how it is produced by charges and currents, and how it is propagated in space and time. The electromagnetic field is described by two quantities, the electric component and the magnetic component, both of which change in space and time and are perpendicular to each other and the direction of propagation.

Interaction with Matter

Electromagnetic waves are modified as they pass through a material medium. The medium may be a solid, liquid, gas, or PLASMA. (A plasma is an ionized gas, that is, a gas at a sufficiently high temperature so that the violent collisions of the atoms have dislodged one or more electrons from each atom.) As the wave propagates through the medium, each charged particle experiences a force that causes it to oscillate with the frequency of the wave. The oscillating charges modify the electric and magnetic fields. Consequently, the propagation characteristics of the wave are changed. One of these changes is simply the change in the velocity of propagation from the velocity in a vacuum, to a velocity that depends on the index of refraction characteristic of the medium. A consequence of this altered velocity is the phenomenon of REFRACTION.

One would expect that as the particles of a medium were set into motion in response to the field of a wave, they would experience frictional forces that would dissipate their energy, and hence energy would be absorbed from the wave. This absorption does occur. The absorption coefficient (see ABSORPTION, LIGHT) depends on the frequency of the radiation. For some cases, such as waves propagating through plasmas, the viewpoint of frictional forces absorbing the energy is a fair approximation to reality. In these cases the friction is supplied by the collisions among the particles as they move in response to the waves. In other cases, such as light passing through gases and transparent solids, quantum theory (see below) must be invoked to explain the absorption process. In these cases absorption occurs when an electron can absorb the energy of a photon and jump from one energy state to a higher one.

The electromagnetic spectrum is a continuous series of electromagnetic waves moving through space at the speed of light and differing only in wavelengths, frequencies, and energy contents. Included are radio, infrared, light, and ultraviolet waves, as well as X-rays and gamma rays.



Quantum Electrodynamics

The classical theory of electromagnetic radiation was the generally accepted theory at the beginning of the 20th century. The subsequent development of QUANTUM THEORY, however, has greatly modified the understanding of radiation. Many phenomena involve interference and diffraction that are most easily interpreted in terms of a wave theory of radiation. Others, such as the PHOTOELECTRIC EFFECT, seem to require radiation to comprise corpuscules, which are now called photons. The modern quantum theory of radiation, called quantum electrodynamics, reconciles the wave and corpuscular pictures and explains both classes of phenomena.

The energy and momentum of a photon are related to the frequency and wavelength of the wave through a physical constant called PLANCK'S CONSTANT. Thus Planck's constant connects the particlelike properties of energy and momentum and the wavelike properties of frequency and wavelength.

According to the quantum theory of atomic structure, the energy of the atom cannot have an arbitrary value, as would be expected on the basis of classical theory, but rather is restricted to a set of discrete values, the energy states of the atom. Emission of radiation occurs when the atom makes a discontinuous transition from one of these energy states to a lower one; the frequency and wavelength of the resulting radiation depends on the energy states. The atom can also absorb a photon and jump from a lower energy state to a higher one. Each atom has its own distinctive set of energy states, and consequently the presence of an atomic species can be recognized by examination of the emission or absorption spectrum. This has made SPECTROSCOPY important for chemical analysis. Conversely, much has been learned about the structure of atoms by examining their spectra and from them deducing the set of energy levels that gave rise to them.

The modern theory of electromagnetic radiation, quantum electrodynamics, can reasonably claim to be the most successful of all currently existing physical theories (with the possible exception of the theory of gravitation in Einstein's general theory of relativity). It explains with great accuracy the propagation of electromagnetic waves and their emission, absorption, and scattering by atoms, molecules, and solids. In addition it treats satisfactorily the creation and annihilation of pairs of electrons and positrons, their positively charged counterparts. The problems that remain in the theory concern the structure of the elementary particles themselves.

electromagnetic units Electromagnetic units are standards of measurement of electromagnetic quantities. More than 100 years since the appearance of James Clerk MAXWELL's *Treatise on Electricity and Magnetism* (1873), a seemingly bewildering variety of electromagnetic units remain in widespread use. The confusion reflects different standards of convenience and practicality in such fields as electrical engineering, experimental physics, and theoretical elementary-particle physics. These standards have conflicted with each other and with the demands both of strict logic, whereby a different unit is used for each fundamentally different quantity, and simplicity, whereby all quantities ideally are expressed in terms of a single unit.

ELECTROMAGNETIC UNITS

Quantity	*MKSA Unit*	*Gaussian Unit*
Charge, *Q*	1 coulomb	= 2.998×10^{9} statcoulombs
Current, *I*	1 ampere	= 2.998×10^{9} statamperes
Potential, *V*, or electromotive force, *E*	1 volt	= 3.336×10^{-3} statvolt
Electric field, E	1 volt/meter	= 3.336×10^{-5} statvolt/cm
Resistance, *R*	1 ohm	= 1.113×10^{-12} sec/cm
Capacitance, *C*	1 farad	= 8.987×10^{11} cm
Inductance, *L*	1 henry	= 1.113×10^{-12} stathenry
Magnetic flux, Φ_B	1 weber	= 10^{8} maxwells
Magnetic induction, **B**	1 weber/m^2	= 10^{4} gauss
Magnetic field strength, H	1 ampere/m	= $4\pi \times 10^{-3}$ oersteds

While the system of electromagnetic units called the Gaussian, or centimeter-gram-second (cgs) system, is used almost exclusively in theoretical physics, new basic units for charge or current were introduced in the practical system of units used in engineering and in everyday life. These units were standardized by international agreement in the International System of Units, or SI (see UNITS, PHYSICAL). This is derived from the MKSA system of units, which is composed of the meter, kilogram, second, and ampere. The basic electromagnetic unit here is not that of charge, the COULOMB, but that of current, the AMPERE.

The accompanying table expresses the conversion between selected MKSA and Gaussian units, the two systems in most common use today.

electromagnetism see ELECTROMAGNETIC RADIATION; MAGNETISM

electromotive force Electromotive force (emf) is the electric energy commonly derived from a BATTERY or a generator. Usually it is called the electric potential difference, measured in volts, and is not actually a force. Emf is related to electric force, however, since it is the energy required to carry a unit positive charge once around a closed circuit. Thus it is the product of electric intensity or field strength (measured as force per unit charge) and the distance traveled around the closed circuit.

In practical terms, the emf of a battery or an electrochemical cell is equal in sign and magnitude to the electrical potential of the metallic conducting lead on the right, when that of the similar lead on the left is taken as zero, the cell being open. (The terms *left* and *right* refer to the cell as commonly drawn, and have nothing to do with the way the actual cell is built in the laboratory.) Under special conditions the emf is a measure of the free energy of the electrochemical cell reaction. When the emf is positive, the free energy of reaction is negative. The reaction can then proceed spontaneously, and the cell can serve as a source of electric energy.

See also: CHEMICAL ENERGY; CIRCUIT, ELECTRIC; ELECTRICITY.

electromotive series

electromotive series The electromotive series is a listing of elements in order of descending chemical reactivity, as measured by their tendency to undergo OXIDATION AND REDUCTION reactions. The list is arranged in order of decreasing tendency to be oxidized, or give up ELECTRONS. Thus, the list is also in order of descending potential of the elements to serve as reducing agents. The list begins with lithium, the most active reducing agent, or electron donor, and ends with fluorine, the most active oxidizing agent, or electron acceptor. A similar series, including nonmetallic ions and molecules, is called the electrochemical series.

The reducing potential of an element is measured relative to a standard hydrogen electrode with the arbitrary reference value of zero volts. The more negative the potential, the greater is the reducing tendency; the more positive the potential, the greater the oxidizing tendency. Thus, elements that liberate hydrogen from dilute acids are listed before hydrogen in the series and have negative potentials, and elements that fail to liberate hydrogen are listed after hydrogen and have positive potentials. The tendency of an element to reduce (donate electrons to) hydrogen is variously called the electrode potential, the oxidation-reduction potential, or simply the oxidation potential.

The potential of fluorine, for example, is +2.87 volts, whereas the superior reducing agent, potassium, has a potential of –2.92 volts. Oxygen has an electrode potential of +1.23 volts. Oxygen is therefore a better oxidizing agent than potassium, although it is not as good as fluorine. (In some lists of the series the signs of the reduction potentials are reversed, but this is only a convention.)

In general, a metal replaces any other less active metal in the series from solutions of its salts. Thus, zinc from a pure zinc strip immersed in copper sulfate solution replaces the copper ions, and the copper plates out on the zinc strip.

See also: CHEMICAL ENERGY; ELECTROCHEMISTRY; ELECTROLYSIS.

electron

electron The electron is a negatively charged subatomic particle and a constituent of all ordinary matter. Electrons are responsible for many physical and chemical properties of matter, such as the formation of chemical compounds. They are FUNDAMENTAL PARTICLES in that they are not now thought to be composed of simpler particles in the way that, for example, protons are composed of quarks.

The electron was the first subatomic particle to be discovered. The discovery was made by the British physicist Sir Joseph John THOMSON in 1897, through analysis of cathode rays formed in the discharge of electricity through gases. By deflecting the rays with electric and magnetic forces, Thomson showed that they are a stream of negatively charged particles, all of which have the same ratio of electric charge to mass. He also showed that the particles, for which he adopted the name electrons, had masses thousands of times smaller than those of the ATOMS from which they emerged. Recent precise measurements show the charge of an electron to be 1.60218×10^{-19} COULOMBS, and the mass of an electron to be 9.10939×10^{-31} kilograms.

Electrons in Atoms Each neutral atom contains as many electrons as it has protons in its nucleus. The electrons are bound to the nucleus by their mutual electrostatic forces (see ELECTROSTATICS). Electrons occupy most of the volume of atoms, although they contribute only a small part of the atomic mass. The spatial distribution of the electrons in an atom follows rules discovered in the 1920s by Niels BOHR, Wolfgang PAULI, and others (see ELECTRON CONFIGURATION). The average distance of the outer electrons from the nucleus is a few tens of thousands of nanometers (one nanometer is a billionth of a meter) in all atoms, while the inner electrons in heavy atoms are much closer to the nucleus. Explaining this size of atoms is one of the important accomplishments of QUANTUM MECHANICS. The tendency of atoms to resist interpenetration, which is responsible for the solidity of matter, is a consequence of Pauli's EXCLUSION PRINCIPLE, which holds that two electrons cannot occupy the same point in space.

When two or more atoms are near each other, their electrons can bind them into stable configurations known as MOLECULES (see CHEMICAL BOND). This binding can take place by having different atoms share some electrons (covalent bonds) or by the transfer of electrons from one atom to another (ionic bonds).

Unbound Electrons in Metals and Plasmas. In crystalline solids, such as metals (see CRYSTAL), some of the electrons are detached from atoms and move almost freely through the whole solid. These unattached electrons are responsible for such characteristic properties of metals as electrical conductivity (see CONDUCTION, ELECTRICAL). Unbound electrons are also found in PLASMAS, a form of matter that exists at high temperatures inside stars.

Quantum Theory of Electrons. In addition to charge and mass, electrons have properties that can be understood only with the use of quantum theory. One such property is spin, which can be thought of as rotation about an axis passing through the electron. Spinning electrons act as small magnets, a fact that plays an important role in such phenomena as ferromagnetism (see MAGNETISM).

According to quantum theory, electrons and all other subatomic particles have wave properties. For an electron with an energy of an ELECTRON VOLT, its wavelength is a few nanometers, the size of an atom itself.

Quantum mechanics also led to the discovery of the POSITRON, the antiparticle of the electron (see ANTIMATTER), which has the same mass and spin as the electron but an opposite charge.

Technological Applications of Electrons. Because of their electric charge and small mass, electrons are easy to manipulate with electric and magnetic forces. When electrons are accelerated, as in a radio antenna, they emit light (see ELECTROMAGNETIC RADIATION). These facts have led to an immense number of technological applications of electrons (see ELECTRONICS). One example is the television tube, a development of the CATHODE-RAY TUBE in which electrons were first discovered. Another is the ELECTRON MICROSCOPE, which uses the fact that the wavelengths of the waves associated with electrons can be much smaller than those of visible light, and therefore can resolve otherwise invisible objects such as viruses.

electron configuration The ELECTRON configuration of an ATOM is the arrangement of the atom's electrons with respect to its nucleus. The configuration is usually given for the ground state of an atom, that is, the state in which the overall energy of the atom takes on its lowest possible value. If the atom has more energy, its electron configuration differs from that of the ground state.

Electrons are commonly pictured as small particles orbiting the larger atomic nucleus. In physics, however, electrons are described by QUANTUM MECHANICS, which does not allow for precise orbits. A description of the electron configuration of an atom, therefore, specifies only probabilities for locating the electrons within different regions centered on the nucleus and known as orbitals. This kind of information nevertheless is sufficient to determine the atom's chemical and physical properties.

The electron configuration of an atom as a whole can be imagined to be the result of successively adding negatively charged electrons to a bare, positively charged nucleus until the atom as a whole is neutral. According to basic principles of quantum mechanics, an electron may occupy only certain energy levels. Each energy level is designated by a principal quantum number, *n*. This number describes the size of the electron probability distribution—that is, the region, or shell, in which an electron most probably moves. The electrons most tightly bound to the nucleus occupy the lowest energy level ($n = 1$). Higher levels are numbered consecutively 2, 3, 4, and so on. The first electrons go into the lowest shells until these are filled. Those added later go into higher shells. Thus, in a hydrogen atom, which has a single electron, the electron is to be found in the 1 shell.

Quantum mechanics also limits the electron population in any one of these levels to a certain number. From the nucleus outward, for example, the first four shells have a maximum population of 2, 8, 18, and 32 electrons, respectively. In addition, shells are split into sublevels, or subshells, having slightly different energies. In order of increasing subshell energy level, the subshells are designated by the letters *s*, *p*, *d*, and *f*, which derive from the field of spectroscopy. These four subshells are limited to populations of 2, 6, 10, and 14 electrons, respectively.

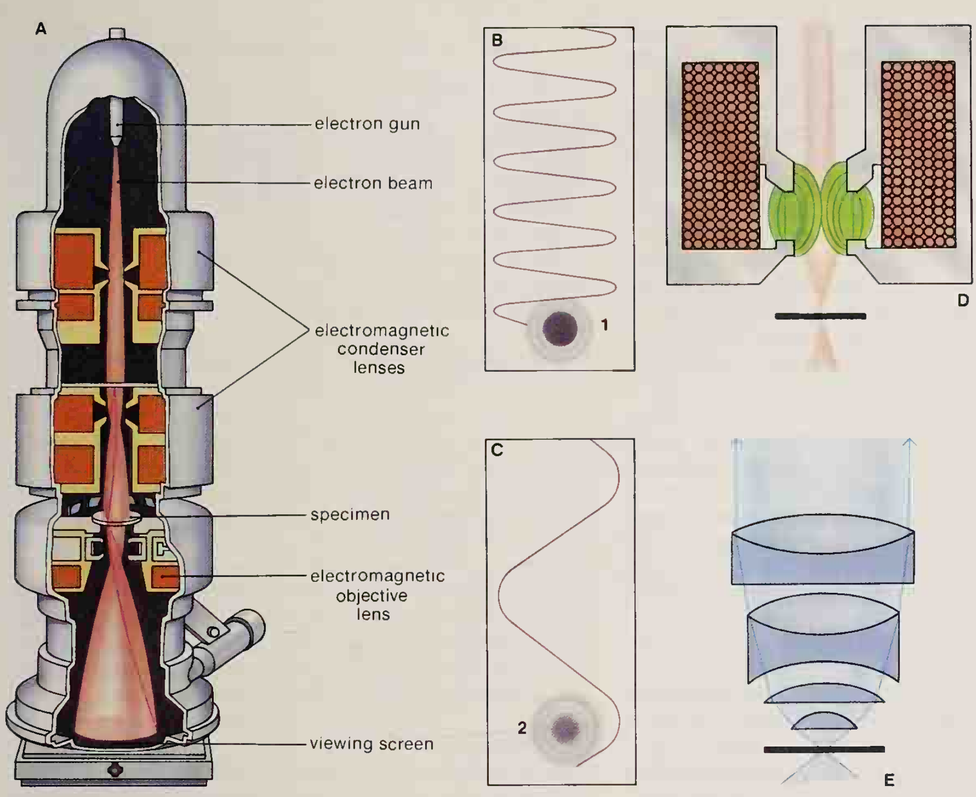
The electron configurations of atoms are indicated by listing these shells and subshells and their populations. Hydrogen, as indicated, has a single electron in the 1 shell, which is considered to consist of a single *s* subshell. The notation for this configuration is $1s^1$. The superscript indicates the number of electrons in the subshell. Helium has two electrons, which fill the subshell to capacity; the notation is $1s^2$. Oxygen has eight electrons: two in the 1*s* subshell, two in the 2*s* subshell, and four in the 2*p* subshell; the notation is $1s^22s^22p^4$. Other elements are similarly described, and handbooks of chemistry and physics provide tables of the electron configurations of the elements. Elements whose numbers of electrons correspond to completely filled shells, such as helium, tend to be chemically inert, because additional electrons must enter a higher shell.

electron microscope The electron microscope is an instrument that exploits the extremely short effective wavelengths of accelerated electron beams to form images in which fine detail is resolved. Optimally, separations as small as 0.1 nanometers (10^{-10} m) can be observed; resolutions of 2 nm (2×10^{-9} m) are common. The electron microscope supplements the standard light MICROSCOPE, the useful magnification of which is limited by the wavelength of visible radiation.

Electron microscopy is widely used in biological studies of the structure of individual cells and large molecules, and it has made a significant contribution to the understanding of the complexities of cellular structure. The applications of the electron microscope are being extended to clinical procedures in medicine such as kidney biopsies. In the physical sciences, applications include studies of the fine structure of metals and crystalline materials and the observation of electron diffraction patterns.

Transmission Electron Microscope. The transmission electron microscope is analogous in optical design to the light microscope; instead of a beam of light, however, a beam of electrons is made to pass through a thin sample. The source of the electrons is a gun that accelerates electrons through a potential in the range of 40 to 100 kilovolts (kV). The electron beam should be monochromatic (of a single wavelength) and correspond to a uniform accelerating potential. Because electrons scatter in the air, the electron microscope column must be kept at a vacuum of 10^{-4} torr (a torr is a unit of pressure equal to 1/760 atmosphere) or better. Electron lenses are appropriately shaped magnetic or electrostatic fields. The condensor lens focuses electrons at the specimen; the objective, intermediate, and projector lenses produce the image that is observed on a fluorescent screen or recorded on a photographic plate.

Applications of electron microscopy have depended on the development of suitable methods for specimen preparation. Specimens must be resistant to both dehydration in the vacuum and beam damage, so that the bombardment with electrons will not lead to excessive overheating and subsequent destruction. Because multiple scattering of electrons by the specimen destroys contrast in the image, the specimen must be extremely thin. The specimen may be a suspension of small particles or an ultrathin


A
electron gun
electron beam
electromagnetic condenser lenses
specimen
electromagnetic objective lens
viewing screen
B
1
C
2
D
E

An electron microscope (A) and an optical microscope produce magnified images of small objects in essentially the same way. An electron microscope, however, uses the wave properties of electrons (B) instead of light (C) for illuminating the object, and electromagnetic fields (D) instead of glass lenses (E) for focusing. In both cases, diffraction rings become visible about an image at high magnifications and cause blurring. It is known that smaller diffraction rings, (1, 2) result when shorter wavelengths of radiation are used. Because the electron wavelengths now in use are about 12,500 times smaller than those of visible light, electron microscopes can magnify objects 1,000,000 times, compared with 2,000 times for optical microscopes, before blurring occurs.

section prepared by methods analogous to those of light microscopy. The specimen is supported on a metal mesh coated with a thin film of low scattering power. Staining in electron microscopy, as in light microscopy, involves the use of chemicals to enhance contrast in the image and make minute structures visible.

Recent advances in electronics have been used to diminish the variation in voltages of electron microscopes and have resulted in better resolution on the atomic level. High-voltage electron microscopes, using million-volt electron beams, have greater penetrating powers than do ordinary electron microscopes. The advantage does not lie in greater resolving power but in increased penetration.

Scanning Electron Microscope. The scanning electron microscope, which came into widespread use in the 1960s, also produces a three-dimensional image from secondary, or reflected, electrons. In scanning electron microscopy, a tiny beam of electrons is directed rapidly over the sample's surface; a closed-circuit TV is used to obtain images of specimens illuminated by a spot probe that is in constant motion. The microscope column acts as a high-resolution camera tube with the specimen as the target. For the scanning electron microscope, specimens are prepared by coating intact surfaces with metal. Although resolution is limited to about 10 nm, readily interpretable images of surface topography result.

In the mid-1980s the scanning tunneling microscope (STM) began to revolutionize the study of surfaces. STMs exploit the TUNNEL EFFECT of electrons to produce sharp surface images. Scientists are able to view individual atoms and learn more about their structure. The STM also has technological uses, as in the fabrication of materials

This scanning electron microscope photomicrograph of a small portion of a common daisy plant illustrates the great detail and large depth of focus that can be obtained.

on a microscopic scale. It has been used, for example, in the production of diffraction gratings and of recording devices for computer disks.

In scanning transmission electron microscopy, the specimen can be examined without staining or shadow casting. A scanning transmission electron microscope scans a specimen instead of irradiating it all at once (as does the transmission electron microscope), and it forms its image of the specimen from the transmitted electrons instead of the secondary electrons (as in scanning electron microscopy). Fewer electrons are needed to record an image than with other electron microscopes, so the radiation damage to the specimen is minimized.

electron optics Electron optics is a branch of physics concerned with the study of beams of electrons, and is analogous to the study of LIGHT rays. The principles of electron optics have application in such areas as the design of television tubes, cathode-ray tubes, and electron microscopes and the study of the submicroscopic structures of crystals and free molecules. Electron optics is based on the principle of wave-particle duality, a basic tenet of QUANTUM MECHANICS.

electron tube Electron tubes are devices consisting of a metal, ceramic, or glass shell and a number of ELECTRODES that can control the conduction of current to generate, rectify, amplify, or convert electrical signals. They may be classified as vacuum or gas-filled tubes, although the degree of vacuum varies widely.

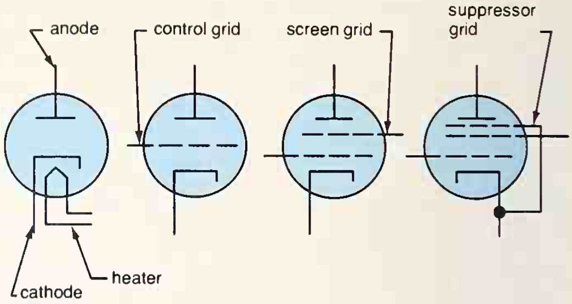
The Diode

The first DIODE was developed by Sir Ambrose FLEMING in 1905, but the basic principle of a current passing in only one direction through such a device was first observed by Thomas EDISON in 1883. The diode consists of only two electrodes—the CATHODE and the anode (plate). These electrodes are common to all other electron tubes developed later that work on the same principle. In order to liberate electrons, the cathode must be heated.

The electrons that are "boiled off" from the cathode have a negative charge. If the anode is positive, the electrons flow from the cathode toward the anode and around the external circuit back to the cathode. If, however, the anode is negative, as a result of an externally applied voltage, the electrons are not attracted to the anode, and no current flows through the diode. Thus a diode permits current to pass through it in only one direction, depending on the externally applied voltage. If this voltage is alternating, the diode is said to rectify the current, that is, convert it from alternating current (AC) to direct current (DC). Fleming used the diode, initially called the Fleming valve, to detect high-frequency radio waves. It was a milestone in ELECTRONICS.

The Triode

Not long afterward, in 1907, Lee DE FOREST, an American inventor, added a third electrode to the Fleming valve to produce the TRIODE. This third electrode, called a control GRID, was a zigzag wire placed between the cathode and the anode. If a negative voltage is applied to this grid, the flow of electrons through the tube to the positive anode can be controlled. This is the important principle of amplification: a small signal, or voltage, on the grid controls a large current in the external plate circuit, and a larger voltage can be developed in this plate circuit. Thus the triode can provide voltage amplification, or gain, to amplify weak signals for telegraphy and radio communication applications and can be used as an AMPLIFIER.



The standard symbols for four common electron tubes are (left to right) *diode, triode, tetrode, and pentode.*

The Tetrode

Initially, electron tubes were applied mostly in radio RECEIVERS. It soon became necessary, however, to develop tubes that could be operated at higher frequencies. The triode, because of CAPACITANCE between its electrodes, was limited in its high-frequency use. This capacitive effect, which could cause tubes to produce an oscillating frequency instead of amplifying the desired signal, could be reduced significantly by adding a fourth electrode, a screen grid between the control grid and the plate. This new device, used for amplifying, was called a tetrode.

Walter Schottky, a German physicist, invented an experimental form of tetrode during World War I. It was the forerunner of a practical four-electrode tube developed in 1924 by Albert W. Hull, an American engineer.

An electron tube containing more than three electrodes is classified as a multielectrode tube. Hence, the tetrode, containing four electrodes, is the simplest multielectrode tube.

The Pentode

Unfortunately, the tetrode introduced some nonlinearities into the characteristics of the tube during low-voltage operation. This was the result of a phenomenon called secondary emission: electrons arriving at the plate from the cathode caused other electrons to be emitted from the plate and collected by the screen grid. This was overcome by Benjamin D. H. Tellegen, a Dutch engineer, who in 1926 added yet another grid called the suppressor grid. This is usually connected to the cathode and serves to suppress the collection of electrons by the screen grid. The result is the modern pentode, or five-electrode tube.

Remaining Uses for Electron Tubes

The type of tube described thus far is satisfactory for operation from DC up to AC having a frequency of 3 GHz (1 GHz = 1,000 MHz or 10^9 Hz, where 1 Hz = 1 cycle per second). The TRANSISTOR, developed in 1947, however, has largely replaced these tubes in new equipment design. This also applies to many of the gas-filled tubes, which, because of the ionization of gases such as mercury vapor, permit higher currents than do vacuum tubes. The advantages of transistors are that they do not require a heated cathode, they operate at much lower voltages, and they are much more compact than tubes.

Some tubes, however, have not been replaced by solid-state devices, although some inroads are being made. It is possible to produce and amplify signals in the microwave region of frequencies by using some special semiconductor devices. Wherever large amounts of power are required, though—for example, in microwave ovens, radar installations, X-ray machines, or mercury-arc rectifiers—electron tubes are the only answer. One area that is expected to be dominated by tubes for some time is that of display. It is not yet economically feasible to replace the television receiver picture tube with semiconductor devices. Light-emitting diodes (LED) of the proper colors, however, do promise such a screen in the future. LIQUID CRYSTAL display (LCD) technology is used in pocket-size television sets. (See also VIDEO TECHNOLOGY).

Microwave Tubes. Special techniques are needed to transmit signals at microwave frequencies, so hollow metal pipes called WAVEGUIDES are used. To produce a resonant circuit (a circuit that has peak response to a particular frequency) would require a parallel connection of a coil, or inductor, and capacitor at low frequencies. At microwave frequencies this is achieved by using a cavity, which may be constructed of brass, copper, or aluminum. Important types of vacuum electron tubes used to generate or amplify microwave signals are the klystron, magnetron, and traveling-wave tube.

The klystron can develop power as high as several hundred kilowatts for use in TV transmitters, RADAR, and tropospheric scatter communications. The magnetron is used in MICROWAVE OVENS. The TRAVELING-WAVE TUBE (TWT), is another high-power, high-frequency tube.

Indicating Tubes. Picture tubes in television receivers, radar displays, and oscilloscopes all use some form of CATHODE-RAY TUBE (CRT). A CRT consists of an electron gun in the neck of the tube that produces and accelerates the electrons toward a fluorescent screen. Electrons that strike the screen cause it to glow. Vladimir K. ZWORYKIN, a Russian-born American scientist, is credited with building (1923) the first workable TV picture tube, the kinescope.

Photoelectric Tubes. Although most photoelectric devices are now solid state, the PHOTOMULTIPLIER tube is still used in detecting and measuring low levels of radiant energy in the ultraviolet, visible, and near-infrared regions. Because it is extremely sensitive and has a fast time response, it can be used in applications such as the measurement of gamma rays. When light energy, or photons, falls on a photocathode (a light-sensitive surface), electrons are emitted. This effect, known as the PHOTOELECTRIC EFFECT, is utilized in photomultiplier tubes.

X-Ray Tube. An X-ray tube is an important example of a very high vacuum tube in which electrons from a heated tungsten-filament cathode are accelerated toward a tungsten target held in a copper anode. This activates the electrons in the atoms of the tungsten, and electromagnetic radiations known as X RAYS are produced.

Gas-Filled Tubes. The few remaining applications of gas-filled tubes involve a cold cathode pool of mercury, which, together with an anode, make up a mercury-pool or mercury-arc rectifier. The mercury vapor becomes ionized, and an arc is established between cathode and anode. Mercury-arc rectifiers are used to convert AC to DC or DC to AC.

electron volt The electron volt (eV) is a unit of work or energy useful on the atomic scale. It is defined as the work done in moving an electron (or particle with the same amount of charge) through a potential of 1 volt. A rather small unit, 1 eV = 1.601×10^{-19} joules or 1.06×10^{-12} ergs. For example, the work required to remove the electron from a hydrogen atom is 13.6 eV. Because of the interconversion of matter and energy, mass can be stated in energy units. Scientists often find it useful to give the mass of the electron as 0.511 meV, the mass of the proton as 938.3 meV, and the mass of the neutron as 939.6 meV.

electronegativity see ELEMENT

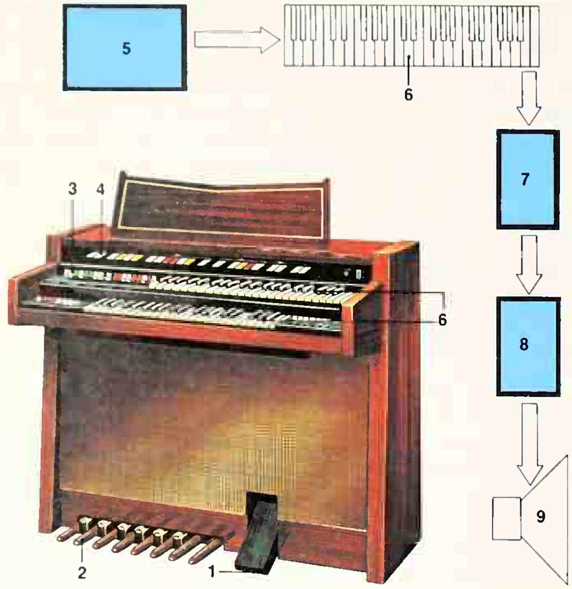
electronic church see RELIGIOUS BROADCASTING

electronic mail Electronic mail refers to messages that are transmitted from computer to computer over ordinary telephone lines under the direction of an intermediate service. This service is a "host" computer that receives messages, holds them, and sends them to the proper destination. With this system, it is not necessary for the sender and receiver of a message to be connected simultaneously. A user of electronic mail needs a microcomputer, or any computer, a MODEM, a printer (see PRINTER, COMPUTER), a telephone line, and an electronic-mail service. Electronic *voice* mail operates in a similar fashion, electronically storing voice messages.

electronic music Electronic music is any music whose primary sound sources are either electronically generated or electronically reproduced. Composers use these methods to create sounds not otherwise available, to synthesize the sounds of acoustic instruments, and to achieve complex rhythmic combinations that might otherwise be unperformable.

Electrical sound experimentation began in the 19th century, and in 1906, Thaddeus Cahill introduced the 200-ton Dynamophone or Telharmonium, which produced sounds by AC-current–operated dynamos.

Electronic instruments of the 1920s included the



The Hammond organ, one of the best-known electric organs, is named for its inventor. The electric organ creates sound electronically, unlike the traditional organ, which produces sound by forcing air through pipes. The volume pedal (1) *controls the loudness. The pedal board* (2) *has pedals arranged like the notes of a keyboard and can produce a bass line of four to eight notes with the touch of a pedal. Tone bars* (3) *and tabs* (4) *provide various special tone effects. Oscillators* (5) *generate pulses of electric current that correspond to pitch levels on the keyboard* (6). *The pulses are modified by the filters* (7), *made greater by the amplifiers* (8), *and fed out through loudspeakers* (9).

Theremin, the Ondes Martenot (later used by Olivier Messiaen), and the Trautonium (used by Paul Hindemith). Interest in such devices continued. In 1948, Pierre Schaeffer, a radio engineer and broadcaster in Paris, composed *Étude aux chemins de fer* (Railroad Étude), based on taped train sounds. It was the first piece of *musique concrète*: music in which tape manipulation is applied to natural and mechanical sounds.

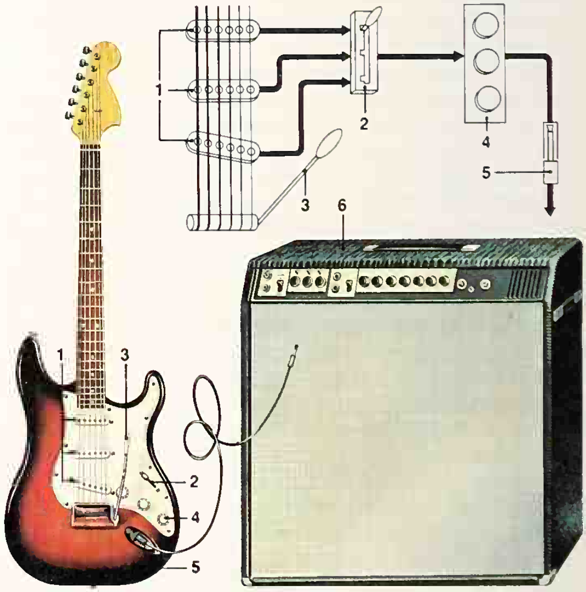
It may never be known who composed the first purely electronic piece using no outside sound sources. Herbert Eimert and Robert Beyer produced such music as early as 1953 in the studio of Northwest German Radio, Cologne, West Germany. Later, a leading figure at the Cologne studio was Karlheinz Stockhausen.

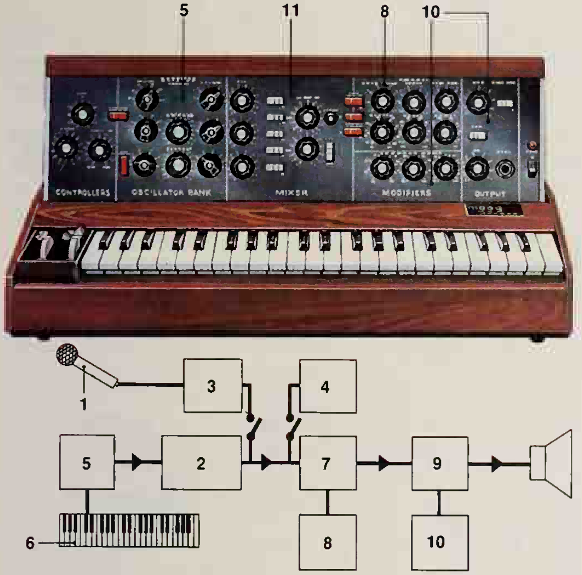
On Oct. 28, 1952, the first U.S. public concert of tape music took place at the Museum of Modern Art, New York City. It included Vladimir Ussachevsky's *Sonic Contours* and Otto Luening's *Low Speed, Invention*, and *Fantasy in Space*. Luening and Ussachevsky established the Columbia-Princeton Electronic Music Center in New York City and Princeton, N.J.

In 1955, RCA developed the Olsen-Belar Sound Synthesizer, Mark I. Its sound sources were oscillators that produced wave forms containing all possible harmonics. Four years later, Columbia-Princeton acquired Mark I's improved successor, Mark II. Luening and Ussachevsky worked with this instrument, as did Milton Babbitt, Mario Davidovsky, Charles Wuorinen, and Bülent Arel. Later, smaller synthesizers were developed. The portable keyboard models are ideal for concert or home use. They are especially popular in rock music. Some early synthesizers were the Moog, the Buchla, and the ARP.

Early systems to notate electronic music were approximate at best. With the extension of copyright protection to sound recordings, notation is now frequently unnecessary. Today there are as many types of electronic music as there are types of listener and performer. Produced during the first few decades of electronic music's history have been tape pieces based on animal sounds (Dika Newlin, *Purr*); classical studio electronic music (Stockhausen, *Gesang der Jünglinge*; Babbitt, *Composition for Synthesizer*); music for tape and live performers (Robert Ashley, *The Wolfman*); music for synthesized voice sounds (Charles Dodge, *Speech Songs*); transformations and extensions of a solo instrument (Meyer Kupferman, *Superflute*, for flute and recorded flutes); "realizations" of classical works by electronic means (Walter/Wendy Carlos, *Switched-On Bach*); tape loops going out of phase with each other (Steve Reich, *Come Out*); music designed to be heard only through recordings (Morton Subotnick, *Silver Apples of the Moon*); and many more.

A solid-body electric guitar (left) *electronically converts vibrations of the strings into sound. The body acts primarily as a string bearer and unlike an acoustic guitar, can be almost any shape, since it affects the sound to a limited extent. The strings produce a note that is converted into an electric signal by the pick-ups* (1) *that are selected by the pick-up selector* (2) *according to the tonal color desired. Depressing the tremolo arm* (3) *lowers the pitch of the notes by reducing tension in the strings. Tone and volume controls* (4) *feed the signal through the jack-plug* (5) *that connects the guitar to the amplifier* (6). *The amplified sound is then fed out through loudspeakers.*





The "Mini-Moog" synthesizer has five sound sources: three oscillators (2), *which produce pitched tones; one pink-white noise source* (4) *for background sounds; and a microphone amplifier* (3), *which boosts live signals introduced through the microphone* (1). *These sounds can be regulated by the oscillator controls* (5) *and keyboard* (6) *and are combined, or "mixed," by the mixer controls* (11). *They pass through a filter* (7), *which suppresses various harmonies, and then through the amplifier* (9), *which controls the volume intensity. The filter and amplifier have their own contour generators* (8, 10).

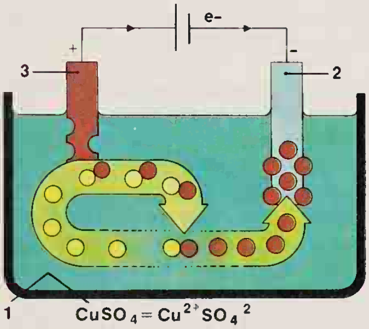
electronic surveillance see INTELLIGENCE OPERATIONS; WIRETAPPING

electronics Electronics is a branch of physical science that deals with the behavior of ELECTRONS and other carriers of electric CHARGE as they flow in vacuum, in gases, and in semiconductors. A flow of electric charge is called an electric current, and a closed path that the electric charges can follow is called an electric CIRCUIT. Modern electronics began in the early 20th century with the invention of ELECTRON TUBES that could store and amplify electrical charges and signals respectively. Since then the technology of SEMICONDUCTORS has replaced, in most cases, that of electron tubes, and electronic circuits have been made smaller, more complex, and more efficient. The diversity of the applications of electronics can be seen in the following devices: COMPUTER, MICROWAVE OVEN, RADAR, RADIO, SOUND RECORDING AND REPRODUCTION equipment; VIDEO; and X-RAY TUBE. The field of ELECTRICAL AND ELECTRONIC ENGINEERING is related to electronics.

See also: INTEGRATED CIRCUIT; MICROELECTRONICS; TRANSISTOR.

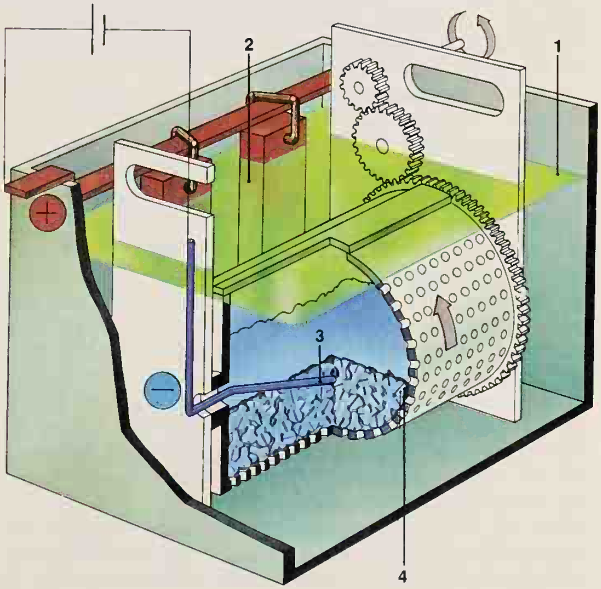
electrophoresis [ee-lek'-troh-fuh-ree'-sis] Electrophoresis is the process by which charged particles suspended in a solution may be separated through the application of an electric current. Electrophoresis was developed by Arne Tiselius. The process is used in medicine and biochemistry in order to separate, identify, and measure the amount of various proteins and lipids in the blood. The most widely used apparatus provides a thin membrane through which an electric current from a carefully regulated power supply is passed.

electroplating Electroplating is the deposition of a metal onto a metallic surface from a solution by ELECTROLYSIS. It is used for purposes of decoration and protection of the metal. Metals commonly used to plate surfaces are silver, nickel, chromium, cadmium, zinc, gold, and copper. In the case of copperplating, for example, elec-



Electrolysis principles are applied in commercial electroplating. In copper plating, copper from copper sulfate electrolyte (1) *is deposited on the object to be plated, which serves as the cathode* (2). *Simultaneously, copper anode atoms* (3) *go into solution to replace the copper removed.*

A modern barrel electroplating machine can plate many objects at the same time. It consists of a tank containing the electrolyte (1), *anode* (2), *cathode* (3), *and a rotating, perforated cylinder that contains the objects to be plated* (4) *and allows the electrolyte to flow through.*



troplating takes place by means of the reaction of $Cu^{++} + 2e^- \rightleftharpoons Cu$. Cu^{++} in this equation represents an ion that is carried to the metal surface to be plated, known as the CATHODE, from the source of the metal being plated, known as the anode. The ion is forced to the cathode by an external source such as a BATTERY. The electrolytic solution is a salt of the metal being plated; in the case of copperplating, it is copper sulfate, $CuSO_4 \bullet 5H_2O$.

The appearance, adhesion, porosity, and protection value of electroplated coatings depend on several things, including the type of base metal to be plated, the preparation of the metal for plating, and the electrodeposition process itself.

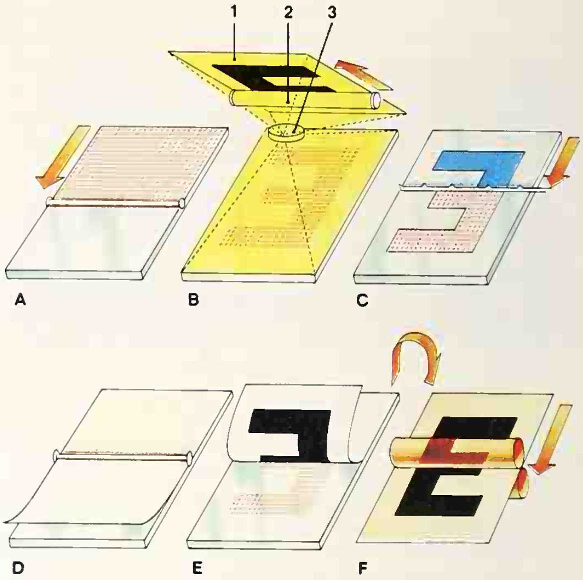
Base Metal. It is not possible to apply high-quality coatings to metals of poor quality. The composition of the base metal is usually known and controlled. The condition of the surface, including the degree and nature of the polishing processes and the presence of pores, cracks, or inclusions, may also have a direct bearing on the character and porosity of the coatings.

Preparation for Plating. It is necessary to have the base metal surface chemically clean in order to secure good adhesion of deposits. The preparation usually involves cleaning—that is, removal of grease and foreign particles—and pickling in the case of steel, or dipping in the case of nonferrous metals, to remove oxides or other compounds, and in some instances, to etch the surface. Because of a thin, natural oxide film, aluminum alloys do not usually respond to the cleaning and surface preparation treatments employed for other metals; special techniques must be used for such alloys.

Electrodeposition. In the plating process many variables are involved that are subject to control. The composition and temperature of the electrolytic bath itself must be closely maintained. Agitation of the bath often permits an increase in current density. Filtration, either continuous or intermittent, is often used to keep the solution free of suspended matter. The average current density should be kept within desired limits for the sake of uniformity in thickness and quality of coatings.

Finally, the anodes should ordinarily be of such composition and structure as to maintain the metal concentration and the pH. Where insoluble anodes are used, the metal content is maintained by replenishment.

Most commercial plating is conducted with motor-generator sets, usually with potentials of from 6 to 12 volts, and with current outputs, depending on the area of work to be plated and the current density.



In the electrostatic Xerox copying process, a coated selenium plate is used that conducts electricity only when it is exposed to light. To make a copy, the plate surface (A) *is first positively charged in the dark with a moving high-voltage wire. In the exposure step* (B), *the original* (1) *to be copied is illuminated by a light* (2). *The reflected light, which is thrown back only by the white areas, is projected through a lens* (3) *onto the charged plate, causing the electricity to be dissipated wherever it strikes. In the developing step* (C), *a negatively charged, thermoplastic toner powder is dusted over the plate, where it adheres to the remaining positively charged areas. A sheet of paper* (D) *is placed over the plate and given a strong positive charge; the toner powder is attracted to the paper, where it forms a direct, positive image* (E). *The image is then stabilized by passing the print between heated rollers* (F), *causing the toner to melt and flow into the fibers of the paper. Since some toner remains on the plate, it is discharged and wiped clean before another copy is made.*

electrostatic printing

electrostatic printing Electrostatic printing is a technique in which electrostatic forces are used to produce copies of documents. It is currently the most popular type of copying machine, having essentially superseded earlier types. Several reproduction processes are based on the principles of ELECTROSTATICS. The two main ones are xerography and Electrofax.

In each method a photoconductive surface is given an electrostatic charge. A discharge occurs when the charged surface is illuminated. Thus, after the surface is illuminated by projecting an image upon it, the amount of charge remaining will depend on the darkness of the original, since white background dissipates the charge.

In xerography the photoconductive surface is a drum coated with the chemical selenium. At the beginning of the copying process the drum is positively charged. Flash lamps illuminate the document to be copied, which has been placed face down on a glass plate. Areas on the drum that correspond to printed areas on the document will not receive light reflected from the document; but where the document is white or unprinted, the corresponding areas on the drum will be illuminated and will lose their charge. A negatively charged dark powder called toner is then wiped across the drum surface; the charged areas will hold the toner. Positively charged copy paper is brought against the drum surface, and the toner is transferred to the paper, which is heated to fuse the toner particles into the paper fibers.

Xerography (meaning "dry printing") was invented by Chester F. CARLSON in 1938 and developed by the Xerox Corporation. The Electrofax process is similar to xerography, except that the paper itself, rather than the drum, is coated. Other, newer electrostatic printing methods use lasers, ink jets, or heat-sensitive ribbons to print (see PRINTER, COMPUTER).

electrostatics Electrostatics is the study of phenomena resulting from electrical charge, or ELECTRICITY, that is at rest.

Static Electricity. The accumulation of electrical charge causes static electricity. It makes the air crackle and hair stand out. This phenomenon is most noticeable when the dryness of the air inhibits the recombining of charges that have become separated by friction or by other means. Static electricity is not as evident on a humid day, because the resistance to current is reduced by the moisture, and the static charge can leak off the objects. Under ideal conditions, the static charge accumulated when shoes are scuffed on a carpet exceeds 20,000 volts. Although this may cause a painful shock, it is not harmful, since low current is involved.

Application. Electrostatic force causes the deflection of the electron beam in a television tube. The beam moves through two sets of parallel plates, one oriented vertically and one horizontally. An electric field is set up by charging the plates. This imposes a force on the electrons and they are deflected from their original course. The two sets of plates work together to sweep the beam over the entire face of the tube in only a few milliseconds.

The electrostatic precipitator is an important industrial application of static electricity. Most of the polluting smoke particles rising in a smokestack are electrically charged. By placing electrically charged plates in the stack, the particles can be forced into a collector where they are removed.

High-voltage electrostatic fields are responsible for natural lightning. Similar intense fields can be developed in the laboratory by using devices such as the Van de Graaff generator to accelerate charged particles useful in research and industry.

electrotype In commercial book and magazine printing, electrotypes are high-quality duplicates of LETTERPRESS plates or type forms, made using an ELECTROPLATING process. A plastic mold is made of the original plate or form. The mold is sprayed with a silver nitrate solution to make it electrically conductive and placed in an electroplating bath, where a thin shell of copper is deposited on it. The shell, which now duplicates the original plate, is stripped from the mold and backed with a layer of lead. Electrotypes can be either flat or curved. For long printing runs, the shell face may be nickel-, chromium-, or iron-plated. The STEREOTYPE is a less-durable version of the electrotype.

electroweak theory In theoretical physics, the electroweak theory is a mathematical model that indicates a unification of two of the fundamental forces of nature: the weak force and the electromagnetic force. Primarily developed by Steven Weinberg, Abdus Salam, and Sheldon Glashow, who shared the Nobel Prize for physics in 1979, the electroweak theory predicted successfully (confirmed in 1983) the existence of subatomic vector BOSONS that carry the electroweak force.

See also: FUNDAMENTAL INTERACTIONS; GRAND UNIFICATION THEORIES; UNIFIED FIELD THEORY.

elegy An elegy in classical literature was any highly serious poem written in alternating dactylic hexameter and dactylic pentameter. In later periods, however, the genre was usually associated with the themes of mourning or death, as in Thomas GRAY's *Elegy Written in a Country Churchyard* (1750), Percy Bysshe SHELLEY's lament for Keats, *Adonais* (1821), and John MILTON's *Lycidas* (1637), the latter two works in the pastoral tradition originated by THEOCRITUS.

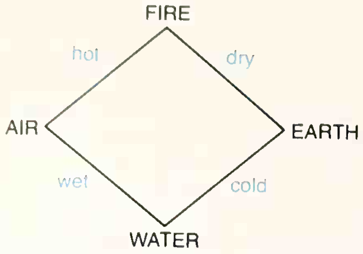
Elegy Written in a Country Churchyard The contemplative *Elegy Written in a Country Churchyard* (1750) by Thomas GRAY is one of the most famous poems in the English language. In the dignity its author lent to nature and the common people as well as in its affinity for melancholy, the poem foreshadowed the English romantic movement. Yet its language, allusions, and pastoral tone, and particularly the sententious direct address of the poem's epitaph, place it predominantly in the classical tradition.

element A chemical element is a sample of matter that cannot be separated into simpler particles by any chemical or physical means except nuclear reactions. Most matter exists as mixtures, which chemists can separate into pure substances (elements or compounds). A chemical COMPOUND is a sample of matter that contains two or more elements in the same proportions throughout and that can be described by a chemical formula. It can be broken down chemically into its elements.

Each element is distinguished by its atomic structure. An ATOM consists of a nucleus of positively charged particles called protons (and electrically neutral particles called neutrons), surrounded by negatively charged particles called electrons. The number of electrons equals the number of protons, and an atom as a whole has no charge. Each element is characterized by the number of protons in an atom of that element. This is called its ATOMIC NUMBER. All atoms with the same atomic number have the same chemical properties. Each element is given a name and a symbol.

Development of the Concept of Elements

In the days of the classical Greek philosophers EMPEDOCLES and ARISTOTLE, the material world was considered to be composed of only four or five fundamental substances, or "elements." Empedocles named earth, air, fire, and water as elements, and Aristotle added a substance called ether, a perfect substance of which heavenly bodies were com-



posed. These elements were thought of as idealizations, however, rather than as material substances.

Several actual elements were known in ancient times. Gold and, to a lesser extent, silver and copper are found uncombined in nature and have been used as pure metals since at least 3000 BC. The ancients also made iron, tin, lead, mercury, copper, and silver by reducing their ores to their elemental forms by smelting. The chemical symbols of all these metals are derived from their Latin names: gold is Au from *aurum,* silver is Ag from *argentum,* iron is Fe from *ferrum,* tin is Sn from *stannum,* lead is Pb from *plumbum,* and mercury is Hg from *hydrargum.* Sulfur and carbon, two nonmetals found uncombined in nature as solids, were also known in ancient times.

Medieval alchemists prepared several elements from compounds or mixtures. They discovered and named arsenic, antimony, bismuth, and phosphorus, but they did not classify them—or the elements known to the ancients—as elements. They recognized, however, that certain material substances could not be changed into others (see ALCHEMY).

The first challenge to the philosophical definition of elements came in the 17th century. Robert BOYLE was a natural philosopher, an active empiricist who believed that experiments should precede and be the test of a theory. In *The Sceptical Chymist* (1661) he stated that only observable and weighable substances should be regarded as elements and that elements are the primary substances from which other substances are made.

Scientific Classification and Discovery of Elements

Antoine LAVOISIER established a firm foundation for chemistry in the 18th century. Lavoisier recognized that weight (more fundamentally, mass) is a property of all matter and that matter (and therefore weight or mass) is conserved in chemical reactions. He also defined an element as a substance that is not decomposable into simpler substances by chemical analysis; therefore, elements must always increase their weight when they react to form compounds. In his *Traité élémentaire de chimie* (Elementary Treatise of Chemistry, 1789) he listed 33 elements. Some, such as phosphorus, carbon, silver, and antimony, had been known since the days of the alchemists. Others, such as oxygen, hydrogen, and zinc, had been isolated during the 18th century.

Atomic Theory. Lavoisier's ideas were confirmed experimentally and theoretically by several chemists, who showed that substances always react in fixed proportions by weight and derived tables of combining weights, and by John DALTON, whose atomic theory extended the concept that matter is composed of fundamental particles called atoms. In 1810, Dalton stated that all atoms of a given element have the same mass. Dalton analyzed experimental data on combining weights and set forth the first table of atomic weights—a table of the elements with numbers indicating their weights relative to one another. Since all these weights were relative, a particular atomic weight had to be chosen as standard.

Jöns BERZELIUS, the most famous chemist of the early 19th century, isolated and identified several new elements and established an accurate table of atomic weights for 50 elements.

The Periodic Table. By 1860 more than 60 elements were known. Several chemists recognized that elements could be grouped into families with similar chemical or physical properties, and various schemes of classification of the elements were proposed. In 1869, Dmitry MENDELEYEV published a PERIODIC TABLE of the elements, grouping them in families and showing several vacancies between the elements known at that time. In 1871 he published a better table and boldly predicted the properties of three of the "missing" elements. Gallium, germanium, and scandium were discovered within 15 years of Mendeleyev's predictions.

Spectroscopy. In 1854 an American physician, David Alter, used prisms to show that the spectra of vaporized alloys produced the characteristic spectral lines of each element in the alloy. Alter hypothesized that each element has a characteristic spectrum and that the spectra of astronomical bodies could be used to identify their constituent elements. Following the invention of the spectroscope (1859), it was demonstrated that the emission or absorption spectrum of a vaporized element is a specific physical property that could be used to identify it.

Cesium was the first element to be discovered (1860) from its spectrum, when two previously unseen blue lines were found in the spectrum of a mineral water solution. Many other elements, including the inert gases, were thereafter identified from their characteristic atomic spectra. Helium, for example, was first observed as a new yellow line in a spectrum of the Sun taken during a solar eclipse in 1868; 27 years later an identical line was found in the spectrum of a gaseous residue obtained from a mineral containing uranium, confirming that helium is an element, and present on the Earth.

Radioactivity. One year after helium was found in a uranium mineral, Antoine Henri BECQUEREL discovered that all uranium compounds emit radiations that darken photographic plates. The search for radioactivity in minerals led to the discovery of many radioactive elements, beginning with polonium and radium by Marie and Pierre CURIE. By 1917 three additional radioactive elements (radon, actinium, and protactinium) had been discovered.

In 1913, Henry Moseley showed that each element emits characteristic X rays and, moreover, that there is a precise mathematical relationship between the X-ray wavelength of an element and its atomic number. Previously, when elements had been classified by atomic weights, the heavier element in each of three pairs (argon and potassium, cobalt and nickel, and tellurium and iodine) preceded the lighter one in the periodic table. Moseley showed that atomic number is the distinguishing property of an element.

Almost all of the elements discovered in the 20th century are radioactive. Two, technetium and promethium, filled previous gaps in the periodic table and were discovered among the products of the nuclear fission of uranium. The others have atomic numbers higher than 92 (uranium). (See TRANSURANIUM ELEMENTS.)

Physical Properties of Elements

Allotropes. Many elements can exist in more than one form; the different forms are called allotropes. Sulfur has several allotropes. Orthorhombic sulfur changes to monoclinic sulfur at 95.5° C; both of these allotropes contain 8-membered rings of sulfur atoms. Other allotropes of sulfur have 6-, 7-, 9-, 10-, or 12-membered rings or long chains of sulfur atoms. Other commonly seen allotropes include those of carbon (diamond and graphite) and tin (gray and white).

Isotopes. Early in the study of radioactivity, it was recognized that one radioactive decay product of radium had properties identical to those of lead. In 1914, Theodore W. Richards and Max E. Lembert announced that the atomic weight of lead from different radioactive ores varied by as much as 1%. In 1913, Frederick Soddy proposed that atoms of the same element, produced from radioactive disintegrations, might have different masses; he proposed the name ISOTOPES for two atoms of the same atomic number but different masses. Shortly after World War I, Francis W. ASTON developed the mass spectrograph, an instrument for determining atomic masses. Aston showed that many nonradioactive elements also have isotopes.

In 1930, James Chadwick explained that almost all atomic nuclei contain neutrons, neutral particles that contribute mass but not charge to the nucleus. Isotopes are atoms of a particular element that have the same nuclear charge (number of protons) as the element but different numbers of neutrons. The number of protons plus neutrons in a given atom is its mass number. Modern mass spectrometers can measure atomic masses very precisely.

THE ELEMENTS

Atomic Number	*Name*	*Symbol*	*Atomic Weight*	*Atomic Number*	*Name*	*Symbol*	*Atomic Weight*	*Atomic Number*	*Name*	*Symbol*	*Atomic Weight*
1	Hydrogen	H	1.0079	38	Strontium	Sr	87.62	75	Rhenium	Re	186.207
2	Helium	He	4.00260	39	Yttrium	Y	88.9059	76	Osmium	Os	190.2
3	Lithium	Li	6.941	40	Zirconium	Zr	91.22	77	Iridium	Ir	192.22
4	Beryllium	Be	9.01218	41	Niobium	Nb	92.9064	78	Platinum	Pt	195.09
5	Boron	B	10.81	42	Molybdenum	Mo	95.94	79	Gold	Au	196.9665
6	Carbon	C	12.011	43	Technetium	Tc	(97)	80	Mercury	Hg	200.59
7	Nitrogen	N	14.0067	44	Ruthenium	Ru	101.07	81	Thallium	Tl	204.37
8	Oxygen	O	15.9994	45	Rhodium	Rh	102.9055	82	Lead	Pb	207.2
9	Fluorine	F	18.998403	46	Palladium	Pd	106.4	83	Bismuth	Bi	208.9804
10	Neon	Ne	20.179	47	Silver	Ag	107.868	84	Polonium	Po	(209)
11	Sodium	Na	22.98977	48	Cadmium	Cd	112.41	85	Astatine	At	(210)
12	Magnesium	Mg	24.305	49	Indium	In	114.82	86	Radon	Rn	(222)
13	Aluminum	Al	26.98154	50	Tin	Sn	118.69	87	Francium	Fr	(223)
14	Silicon	Si	28.0855	51	Antimony	Sb	121.75	88	Radium	Ra	226.0254
15	Phosphorus	P	30.97376	52	Tellurium	Te	127.60	89	Actinium	Ac	227.0278
16	Sulfur	S	32.06	53	Iodine	I	126.9045	90	Thorium	Th	232.0381
17	Chlorine	Cl	35.453	54	Xenon	Xe	131.30	91	Protactinium	Pa	231.0359
18	Argon	Ar	39.948	55	Cesium	Cs	132.9054	92	Uranium	U	238.029
19	Potasium	K	39.0983	56	Barium	Ba	137.33	93	Neptunium	Np	237.0482
20	Calcium	Ca	40.08	57	Lanthanum	La	138.9055	94	Plutonium	Pu	(244)
21	Scandium	Sc	44.9559	58	Cerium	Ce	140.12	95	Americium	Am	(243)
22	Titanium	Ti	47.90	59	Praseodymium	Pr	140.9077	96	Curium	Cm	(247)
23	Vanadium	V	50.9414	60	Neodymium	Nd	144.24	97	Berkelium	Bk	(247)
24	Chromium	Cr	51.996	61	Promethium	Pm	(145)	98	Californium	Cf	(251)
25	Manganese	Mn	54.9380	62	Samarium	Sm	150.4	99	Einsteinium	Es	(254)
26	Iron	Fe	55.847	63	Europium	Eu	151.96	100	Fermium	Fm	(257)
27	Cobalt	Co	58.9332	64	Gadolinium	Gd	157.25	101	Mendelevium	Md	(258)
28	Copper	Cu	63.546	66	Dysporsium	Dy	162.50	103	Lawrencium	Lr	(260)
30	Zinc	Zn	65.38	67	Holmium	Ho	164.9304	104	Unnilquadium	—	(257)
31	Gallium	Ga	69.72	68	Erbium	Er	167.26	105	Unnilquintium	—	(260)
32	Germanium	Ge	72.59	69	Thulium	Tm	168.9342	106	Unnilhexium	—	(263)
33	Arsenic	As	74.9216	70	Ytterbium	Yb	173.04	107	Unnilseptium	—	(261)
34	Selenium	Se	78.96	71	Lutetium	Lu	174.97	108	Unniloctium	—	(265)
35	Bromine	Br	79.904	72	Hafnium	Hf	178.49	109	Unnilennium	—	(266)
36	Krypton	Kr	83.80	73	Tantalum	Ta	180.9479				
37	Rubidium	Rb	85.4678	74	Tungsten	W	183.85				

Values in parentheses give the atomic mass number of the isotope of longest half-life.

Atomic Weights. The modern atomic weight scale is based on the convention that the mass of a ^{12}C atom is exactly 12 atomic mass units. Some elements, such as fluorine, have only one naturally occurring isotope; their atomic weights are measured with mass spectrometers to very high accuracy. The atomic weights of other elements are less accurately known because they are experimental averages of all the naturally occurring isotopes of the given element. The isotopic composition (and, therefore, the atomic weight) of some elements varies according to the source or prior treatment of the sample.

Chemical Properties

Metals and Nonmetals. Most chemical elements are METALS: 75 of the first 103 elements are known to be metals in their elemental state. Francium (element 87) and elements 99 and beyond have chemical properties characteristic of metals, but they have such short half-lives that observable quantities have not been isolated in pure form. Metals are characterized by their weakly bound outermost electrons, whose relative freedom of motion causes the conductivity, luster, and ductility of metals and results in the formation of positive ions (cations) by all metallic elements in ionic compounds.

Seventeen elements are nonmetals. With the exception of the inert gases, they exist as diatomic or polyatomic molecules in their elemental form, share electrons in covalent bonds, and form negative ions (anions) in ionic compounds. Between the metals and the nonmetals are borderline elements called semimetals or metalloids. For example, arsenic (As) has metallic properties, but a molecular As_4 allotrope is known, and the element has both positive and negative oxidation states in its compounds. Thus, semimetals have some metallic and some nonmetallic characteristics.

Electronegativity. Electronegativity is the relative attraction of an atom for electrons in a covalent bond. Elements at the right and the top of the periodic table have the largest electronegativities; fluorine is the most electronegative element, and francium is the least electronegative. Elements with similar electronegativities form covalent compounds with electrons shared equally in bonds: nitrogen trichloride, NCl_3, is a covalent compound. Elements with somewhat different electronegativities form polar covalent compounds, in which the electron cloud forming a bond is displaced slightly toward the more electronegative element: phosphorus trifluoride, PF_3, is a polar covalent compound in which the electron density is greater near the fluorine atoms. Elements with widely different electronegativities form ionic compounds, in which the electronegative atom forms an anion and the electropositive atom forms a cation. Salts are examples of ionic compounds.

Many other properties, both chemical and physical, of an element can be classified and interpreted on the basis of the element's position in the periodic table.

Origin and Abundance of the Elements

The most plausible theory of the origin of the universe is that it formed from the explosion of a tiny, extremely dense fireball several billion years ago. In the first few seconds after this big bang (see BIG BANG THEORY), the energy density was so great that only radiation and fundamental particles existed.

As the universe cooled and expanded after the big bang, however, hydrogen formed and after millions of years condensed into galaxies and then stars. The hydrogen in these first-generation stars burns by forming heavier nuclei and releasing energy, but even if such a star explodes, the heaviest isotope produced is ^{56}Fe. The gaseous products of the explosion of first-generation stars contain many light elements, and when the gases condense to form second-generation stars, many nuclear reactions can take place. Some of these nuclear reactions emit neutrons, which are captured by other nuclei to form heavier nuclei that decay by β-emission to form elements with still higher atomic numbers (as high as $^{254}_{98}Cf$). As a result, the universe contains small amounts of elements heavier than ^{56}Fe, roughly in proportion to their nuclear stability; more than 60 elements have been identified in the Sun's spectrum.

As the Sun formed, the disk-shaped rotating mass of the size of the solar system developed many turbulences. These turbulences led to the infrequent accretion of small masses of heavy elements, ultimately forming protoplanets surrounded by hydrogen-helium atmospheres. When the central mass, the Sun, began radiating energy as a result of its nuclear reactions, hydrogen and helium were driven off the inner planets. The Earth gradually evolved into an iron-nickel core, a silicate mantle, and a silicate crust and later developed an atmosphere and hydrosphere (the bodies of water and ice on the Earth's surface).

Elementary and Secondary Education Act of 1965 The Elementary and Secondary Education Act (ESEA) of 1965, the first major U.S. program of direct financial assistance to primary and secondary schools, was part of President Lyndon B. Johnson's WAR ON POVERTY. ESEA has since been extended and amended several times. Titles II and III of the original act funded libraries, textbooks, experimental programs, supplementary education centers, and regional research laboratories. Most of the money from the billion-dollar program, however, was spent on COMPENSATORY EDUCATION programs under Title I, which allocated it in approximate proportion to the number of low-income families in each state. In 1981 many of the smaller programs of ESEA were consolidated into block grants to the states. Title I remained intact.

elementary particles see FUNDAMENTAL PARTICLES

elephant Elephants constitute the family Elephantidae in the mammalian order Proboscidea. Each of the two living genera has a single species: *Loxodonta africana*, the African elephant, and *Elephas maximus*, the Asian, or Indian, elephant. African elephants are the largest living land animals, although some forest-dwelling African elephants are small. The largest African elephants are 7.5 m

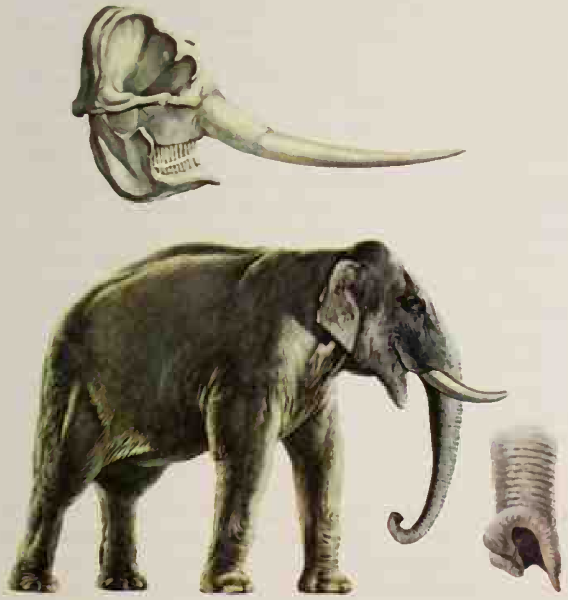
(25 ft) long, including the trunk. They have a 1.4-m (4.5-ft) tail, stand 4 m (13 ft) tall at the shoulder, and weigh 7,500 kg (16,500 lb). The biggest Asian elephants are 6 m (20 ft) long with a 1.5-m (5-ft) tail, stand 3 m (10 ft) tall at the shoulder, and weigh 5,000 kg (11,000 lb).

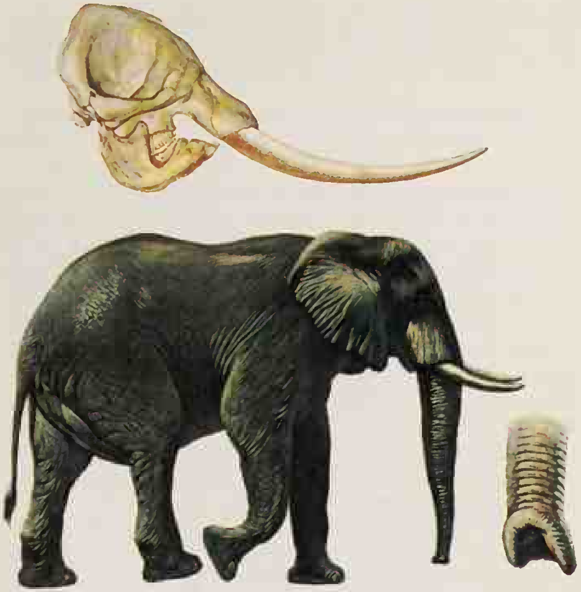
The most distinctive external feature of the elephant is the flexible, muscular trunk, or proboscis, an elongated nose with nostrils at the end as well as one (in the Asian elephant) or two (in the African elephant) fingerlike projections with which the elephant can examine, or even grasp, small objects. Elephants drink by sucking water into their trunks and then squirting it into their mouths. They have extremely large heads and short necks. Both sexes of the African elephant have tusks, which are greatly elongated incisor teeth, one on either side of the upper jaw. The largest known tusk weighed 107 kg (236 lb) and was 3.5 m (11.5 ft) long. Females have smaller tusks. Only male Asian elephants have tusks, and these are usually smaller than African tusks.

Elephants have fan-shaped ears that are up to 1.5 m (5 ft) long in the African genus, smaller in the Asian. The legs are massive and columnar and almost equally wide from top to bottom; the feet are broad and round. Both species have five toes on each forefoot, but the African elephant has three toes and the Asian elephant four toes (sometimes five) on each hind foot. The elephant's thick skin has sparse hair.

The African elephant is native to many parts of southern, central, and eastern Africa. It lives in forests, grasslands, river valleys, and deserts. Its numbers have been diminished by overhunting, mainly for the ivory of its tusks. Where it is protected, it tends to overpopulate and defoliate its range, resulting in starvation. The elephant uses its trunk to strip trees of branches and bark and even uproot them. A ban was placed on ivory trading in 1989 when the African elephant was declared endangered by the United Nations Convention on International Trade in Endangered Species.

The Indian elephant has small ears and one projection on the end of its smooth trunk (right). *Its skull is dome shaped, and, unlike the African elephant, it has no protruding lower jaw.*





The African elephant has large ears and two fingerlike projections on the end of its trunk (right). *It has a less-rounded skull than the Asian elephant, as well as longer legs and bigger eyes.*

Asian elephants live in tropical grassy plains and rain forests. When the food supply is depleted, these elephants move in single file to more promising territory, which may turn out to be a cultivated plantation. Asian elephants are often captured and domesticated.

Elephants' bones lack marrow cavities; they are filled instead with a spongy material through which the marrow is distributed. Their grinding teeth are large and high, and usually only four teeth (excluding the tusks), one on each side of the upper and lower jaws, are present in the mouth at one time. Elephants eat only plant material, as much as 230 kg (500 lb) per day. One or two young are born after a gestation period of about 21 to 22 months.

Elephant Man see NEUROFIBROMATOSIS

Elephanta [el-uh-fan'-tuh] The island of Gharapuri, called Elephanta by the English because of a colossal stone elephant that was found there, is situated 10 km (6 mi) offshore in Bombay harbor, Maharashtra state, western India. The island, about 5.2 km^2 (2 mi^2), is the site of six rock-cut cave temples built during the 8th century AD and dedicated to the Hindu god Shiva. The largest temple, called the Great Cave, is a hall almost 40 m (130 ft) long by 17 m (55 ft) wide; its vast interior space is articulated, as in a structural building, by rows of massive pillars. Large, richly carved panels throughout the interior vividly depict central incidents from the myth of Shiva.

elephantiasis see FILARIASIS

Eleusinian mysteries [el-ue-sin'-ee-uhn] In Greek religion the Eleusinian mysteries were part of a secret cult conducted at the temple of DEMETER in the city of Eleusis, near Athens. The rites were based on the idea of death and rebirth, and celebrated the immortality of PERSEPHONE, daughter of the corn-and-earth goddess Demeter; Persephone had been carried off by the god Hades (also called Pluto), who wanted her as his wife and coruler of the underworld. While Demeter searched in vain for her lost daughter, no crops grew in the fields. Zeus, however, decreed that Persephone would spend the crop-growing seasons on Earth with her mother and the winter season in the underworld with Hades.

The mystery rites were always conducted by the priests of Demeter; the central part of the worship was apparently built around the viewing of corn and the life-storing-planting-new-life cycle of corn. All initiates kept the secrets of the religion guarded and believed that they, too, would enjoy a life after death because of their initiation into the mysteries.

Eleusis [el-oo'-sis] Eleusis, a small Greek coastal town 22 km (14 mi) west of Athens, was famous in ancient times for the Panhellenic sanctuary of DEMETER and Kore (Persephone), and the cult of the Eleusinian mysteries. Occupied since the Bronze Age, Eleusis was dominated by Athens from the 6th century BC until the Roman period. The cult flourished until Eleusis was destroyed (about AD 395) by the Visigothic king Alaric I.

The temple of initiation (Telesterion) is about 600 m^2 (6,450 ft^2), with tiers of seats for 3,000 initiates, and a central "holy of holies" chamber. The sanctuary contained fine examples of Greek and Roman architecture and inscriptions, now in the local museum and the Athens National Museum.

elevated railroad The elevated railroad, or elevated railway (sometimes shortened to "elevated" or simply "el"), is a rapid-transit system that runs on a track built above street level. In general when one road is built over (or under) another, instead of the two roads intersecting on the same level, traffic can flow along both roads without interruption. The use of such overpasses and underpasses is called grade separation; systems that use them are known as grade-separated systems. Trains usually have from two to ten cars; station platforms are placed at the floor level of the car; and the cars have several doors on each side for fast loading and unloading of passengers.

The Old "Els." The need for grade-separated urban transportation became evident in large cities about the middle of the 19th century. Horse-drawn traffic in the streets had become congested. New York City, since it had a rock foundation that made tunneling more difficult, intially chose to build elevated railroads, opening its first line in 1868.

Small steam locomotives were used for propulsion on the first els. From about 1870 to 1900 the els were steadily expanded in New York, and Boston and Chicago began to develop systems.

Beginning in the 1890s the electrification of the elevated railroads made possible cleaner, more efficient transportation. Elevated railroad cars were powered by electricity drawn from a third rail running alongside the tracks. (The overhead electrified wire called a catenary is used primarily to power STREETCARS.)

The popularity of the elevated railroads reached its peak in the 1920s. Despite their advantages, els had the serious drawbacks of noise and unsightliness. Thus, the els began to be replaced with SUBWAYS, resulting in a shrinking network of els in the United States.

Monorails. In the 1960s the monorail gained in popularity. It consists of two types, saddlebag and suspended, and essentially is a railroad car or a train supported by one rail. In the saddlebag type the vehicle straddles a large rail or beamway and is powered by vertical wheels on top of the beamway, with horizontal wheels pressing against the sides of the beamway to stabilize the car. In the suspended type the vehicle hangs from a hollow beamway within which is mounted a motor-driven wheel assembly. The wheels may be conventional, vertically mounted railroad wheels running on twin rails fastened inside the beamway, or the rubber-tired drive wheels may roll on the flat bottom of the beamway, with horizontal, rubber-tired wheels pressing against the inside of the beamway for guidance.

The installation (1959) of a monorail in Disneyland led to much favorable publicity. For the 1962 World's Fair a saddlebag type of monorail was installed. At about the same time, a monorail line was built between the Tokyo airport and that city's central business district.

Engineering-cost studies have, however, shown that, in general, the monorail is not economically practical for a conventional rapid-transit system. Construction costs are higher than for conventional two-track rapid-transit systems. Operating costs also appear to be higher in the rubber-tired versions, because of the higher rolling friction of the wheels.

A relatively recent addition to the technology of intracity travel, often elevated, is the Maglev, the Magnetic Levitation train, prototypes of which have been built in Germany and Japan (see RAILROAD).

Future. Some transportation planners feel that the elevated railroad may yet have a place in mass-transit systems, because it costs less to build an elevated rapid-transit system than to tunnel underground.

elevation As a geographical term, *elevation* refers to the vertical distance that a point on the Earth's surface lies above a standard base level—usually mean sea level. This distance is determined by surveying techniques ranging from trigonometric triangulation to aerial stereophotography. It is indicated schematically on maps by contour lines drawn at fixed intervals. On nautical charts, spot elevations are provided only for conspicuous landmarks and are given in reference to the mean high-water level. On aeronautical sectional charts, terrain elevations are indicated by color changes, the highest elevation on the chart being printed at the top of the contour legend. For obstructions, both elevation above mean sea level and above ground level are given.

In astronomy, elevation refers to the vertical angle between a horizontal and a celestial body.

elevator A mechanism for moving people and freight from level to level in a building or other structure, the high-speed automatic elevator, or lift, has been in use only since the mid-20th century. Beginning early in the 19th century, steam-powered elevators were used to transport freight in factories and ore in mines, but they lacked a safety device to stop the elevator if its hoisting mechanism failed or if its supporting cable broke. In 1852, Elisha Graves Otis (1811–61) designed the first safety device for elevators—a system of spring-operated cams that engaged the guide rails in the elevator shaft if the cable broke. In 1857, Otis installed the first passenger elevator, in a New York store.

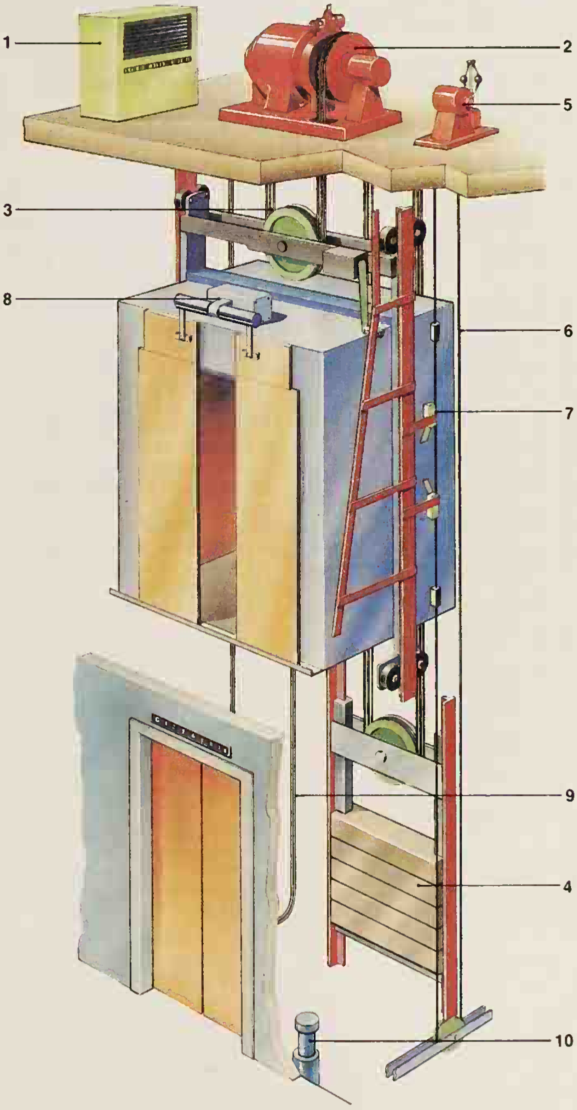
Otis's elevators were steam powered, the elevator car being moved by a system that used a belt-driven winding drum. But it was the invention of the electric MOTOR that made elevators practical. The first electrically driven elevator was installed in a New York City office building in 1889. Improvements have come in higher speeds, smoother rides, and automatic leveling at all floor landings.

High-speed elevators for tall residential or office buildings range in speed from about 140 to 550 m (460 to 1,800 ft) per minute; the higher the building, the greater the speed. Elevator speed determines the type of machinery and the complexity of controls. For speeds greater than 45 m (150 ft) per minute, cable-operated elevators are used. A number of heavy steel cables pass over a cylindrical drum above an open shaft running the occupied height of the building. The drum may be driven through gears or by means of a gearless direct drive. The elevator car, an enclosed cab, is fastened at one end of the cable. At the opposite end is a counterweight. Push-button controls select the destination level and summon the elevator from outside the shaft.

Safety features prevent elevator operation in case any shaft door or the cab door is open, in case of excessive speed, or in case of overtravel above or below the designed limits. A fail-safe magnetically operated brake clamps the drum whenever the car is stopped. In the event of cable breakage, automatic clamps on the cab prevent the car from falling.

For buildings that are not very tall, and where elevator speeds of less than 45 m per minute are judged efficient, a hydraulic mechanism is used. The cab is supported on top of a steel piston enclosed in a cylinder that is sunk into the ground to a depth equal to the rise of the elevator. To raise the car, a pump forces oil into the cylinder, moving the piston upward. To lower the car, oil is released from the cylinder.

A computer-controlled elevator is activated by push buttons that feed passenger call signals into the computer (1). *The computer controls a hoisting motor* (2) *that winds a loop of steel cable* (3), *attached by pulleys to the car and to a set of counterweights* (4). *If the car should fall too fast, a governor* (5), *connected to a safety rope* (6), *activates a braking system. The car runs between guide rails, which carry limit switches* (7) *that stop the car at each floor level. A small motor on top of the car* (8) *opens and shuts the doors. Power is supplied by means of a flexible cable* (9). *Should the car descend below ground-floor level, an oil buffer* (10) *absorbs the impact shock.*



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